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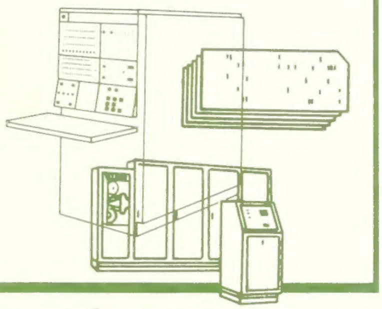
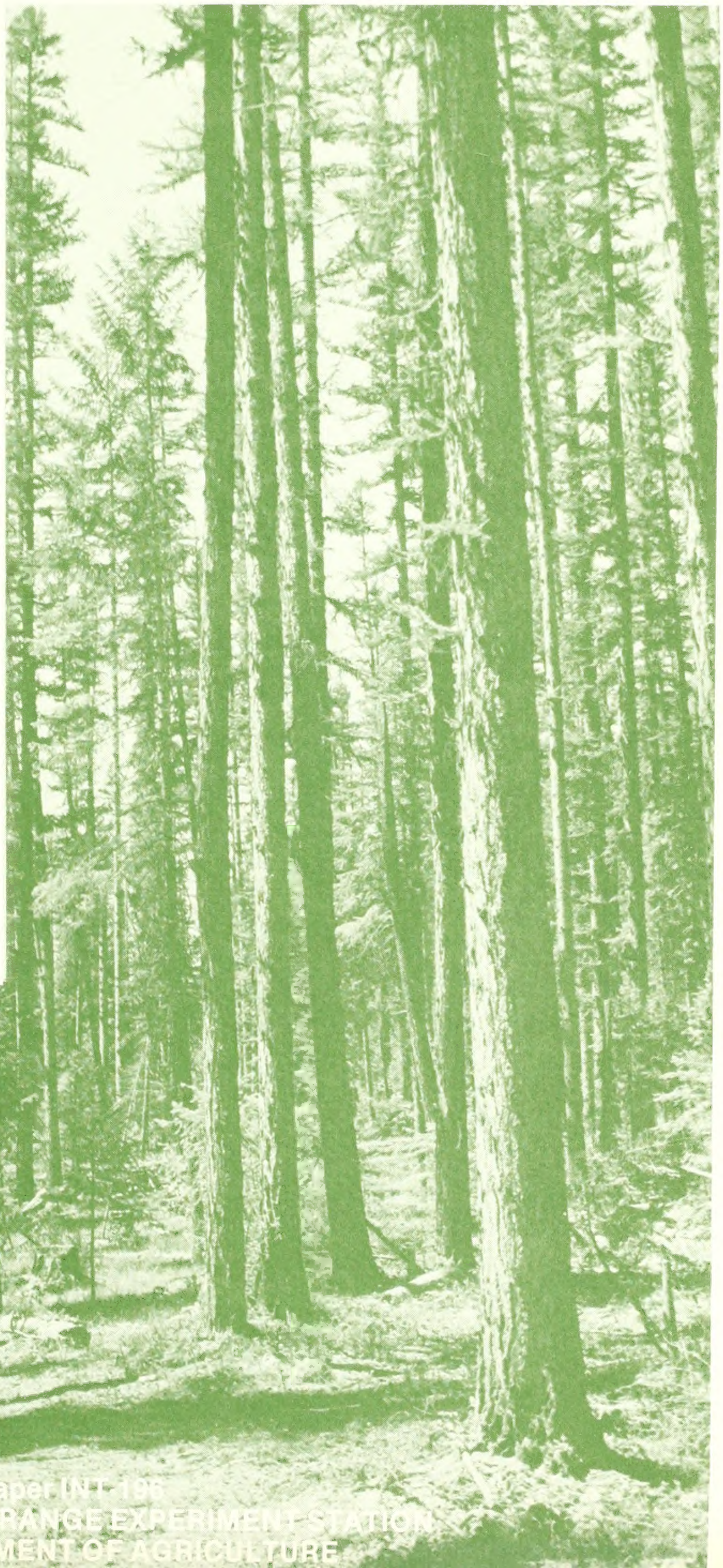
ESTIMATING MERCHANTABLE VOLUME AND STEM RESIDUE IN FOUR TIMBER SPECIES:

Ponderosa pine
Lodgepole pine
Western larch
Douglas-fir

James L. Faurot





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RESEARCH SUMMARY

Presents tables and equations for estimating total cubic volumes of wood, wood residue, and bark for ponderosa pine, lodgepole pine, western larch, and Douglas-fir. Tables represent second-growth trees 80 years old or less, ranging in size from 1-1/2 inches d.b.h. to the maximum diameter measured for the respective species. The equations and tables provide a means for estimating wood and bark residue volumes from tops, bole sections, and smaller submerchantable stems. Tables and equations can also be used to estimate total cubic volume for the size classes, species, and locale sampled.

INTRODUCTION

Estimates of tree volume, based on diameter, height, and species, provide the foundation for many forestry practices. Recent interest in volumes of forest residues, rapidly changing utilization practices, and an accelerated need to manage second-growth stands of timber have created a demand for tables that indicate not only the volume of wood in the merchantable part of a stem, but also the volumes of wood and bark in the nonmerchantable parts, and in stems smaller than the prevailing merchantability standard.

The accompanying tables (appendix) have been prepared mainly for the purpose of predicting stem residue volumes that may result from thinning or harvesting. The trees selected for the study do not exceed 80 years of age, and so may represent stem development in unmanaged second-growth stands. Minimum tree diameter is 1-1/2 inches d.b.h. (o.b.) and the maximum diameter varies by species, given the constraints of age and growing site. The sample trees were obtained from selected stands on both public and private lands in western Montana and include a broad range of growing conditions. Only dominant and codominant trees were measured, and no trees were selected that showed, from ring examination, marked periods of suppression.

METHOD OF STEM MEASUREMENT

All measurements were made on felled trees as shown in figure 1. The total height and d.b.h. (o.b.) of each tree were determined first. To eliminate the problems of disproportionate measure in using a fixed bolt length, the tree was then divided into six segments of equal length for further measurement. A diameter tape was used to measure diameter outside bark at the base of each segment. Bark thickness at the base of each segment was measured using a Swedish bark gage. At thick-barked section the bark gage measurement was augmented with an axe cut, the thickness then measured with an engineer's scale. A minimum of three bark-thickness measurements were made at the base of each segment and the average value was determined. An additional measurement, inside bark, was made at an assumed stump height of 1 foot above the average ground level. All diameter and bark-thickness measurements were recorded to the nearest tenth of an inch. Total tree height was measured to the nearest foot. The segment lengths were converted to inches and measured to the nearest inch.

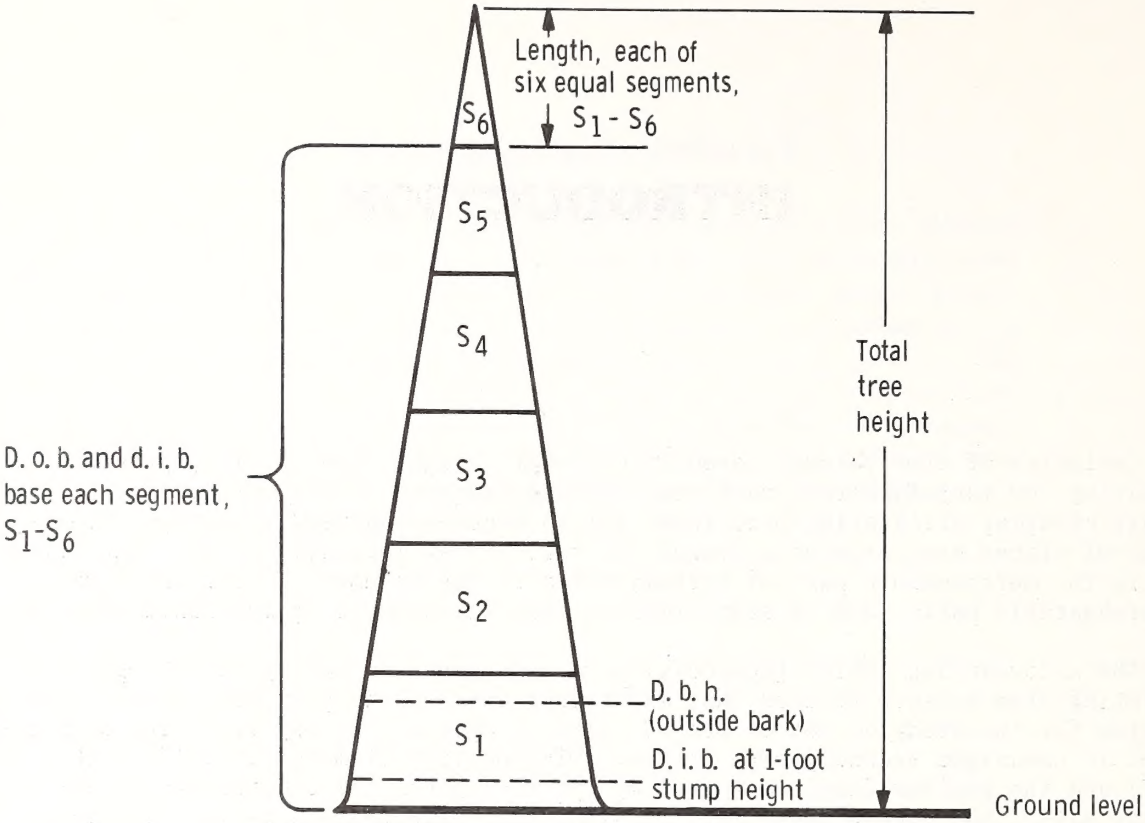

Figure 1.--Stem measurements that describe diameter and height for each sample tree. Designated segments, s_n, divide the total tree height into six equal segments.

BASIC VOLUME COMPUTATION PROCEDURES

Stem Total Wood Volume

The volume of the middle four truncated segments of each tree was obtained by treating the segments as a cone frustrum, while the top segment was treated as a cone. The volume of the base segment was obtained by calculating the stump volume as a truncated cone and adding it to the remaining segment volume. The inside bark diameter was obtained by subtracting double bark thickness from d.o.b. All segment and tree volumes were developed from a computer program specifically written for the data. The volumes were calculated in cubic feet for the entire stem, inside bark, including the stump and top.

Top Volume Above a Specified Diameter

Top volume is defined as the volume, inside bark, of that portion of the stem above a specified minimum top d.i.b., ranging from 2 to 8 inches. For trees in which the specified minimum top diameter occurs low in the tree (for example, an 8-inch minimum top diameter in a 9-inch d.b.h. tree), top volume is further limited to that portion of the stem above an 8-foot bole section. Utilization of at least an 8-foot section above the stump is assumed, regardless of diameter.

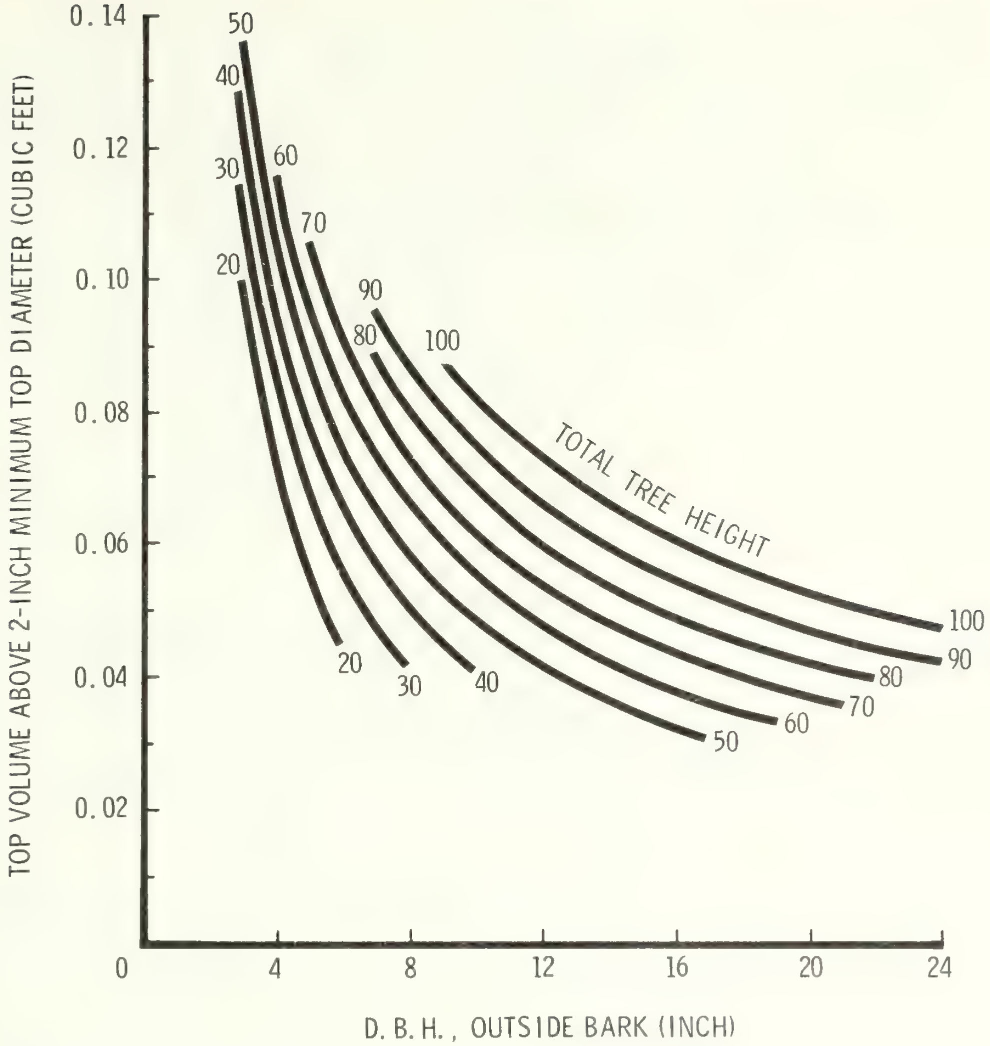

Figure 2.--Top volume, defined as the volume above a specified minimum diameter, varies with diameter of the tree and total height of the tree. Illustrated is the relationship between these variables for ponderosa pine.

Top volumes were calculated by means of the same computer program that was used to calculate total stem volumes. Using the segment diameters and bark thicknesses recorded for the tree, the minimum top-diameter position on the stem was calculated. Volumes of all full segments above this point, plus the volume of a partial segment immediately above minimum top diameter, were aggregated to determine top volume. Top volume is a function of tree diameter and height, as illustrated in figure 2.

Bark Thickness

Bark thickness was obtained using the measured values as recorded from the field sample. However, because of the excessively thick bark at the tree base, only the measurements of the upper five segments were used.

Gross Bark Volume

Gross bark volume is defined as the bark volume for the entire stem without allowance for fissure or void volume. The value was obtained for each tree by subtracting the volume inside bark from the volume outside bark. The volume in each case was calculated in the manner previously described for the calculation of stem volume. Because d.o.b. at stump height was not obtained during the field measurements, that particular value was estimated from the bark-thickness equations developed for each species.

Stump Diameter — D.B.H. Relationship

The relationship between diameter at stump height, i.b., and diameter at breast height, o.b., was obtained for each tree using the information obtained from field measurements.

METHODS OF REGRESSION MODEL CONSTRUCTION

The development of the models for table construction proceeded in four steps: (1) selection of the independent variables, (2) graphic analysis, (3) regression analysis, and (4) final selection of the model.

Development of Tables

The regressions and resulting tables were prepared specifically to make use of measurements that are commonly obtained under field conditions. With this in mind, diameter breast height, outside bark (d.b.h., o.b.), and total height were used as fundamental independent variables for all stem, top, and bark volume estimates. Diameter outside bark was used to predict bark thickness, again because of the relative simplicity of field measurements. Stump diameter, i.b., one of the measurements taken during the data collection, was used as the independent variable in developing the d.b.h.-stump diameter equations.

Random samples, varying from 10 to 20 percent of the total number of observations in each data set, were drawn for graphic analysis. These analyses provided insights for the selection of the form of the variables, from which one or more models were postulated. Stepwise, least squares multiple regression techniques, using the improvement in the "F" statistic as a delimiter, were used to develop the models. When more than one model seemed statistically appropriate, an examination of the residuals was helpful in selecting the final model.

With the exception of the stand volume equations, all volume predictions incorporate logarithmic models. Logarithmic expressions for the estimation of tree stem volume have been widely used since 1933, when the method was proposed by Schumacher and Hall (1933). Investigators in other fields have likewise found the procedure useful (Baskerville 1972; Zar 1968).

Two characteristics are common when describing functional relationships between tree or stem size and volume. First, these relationships are nonlinear; and second, the variation within size classes is neither constant nor directly proportional to tree size. When the data are plotted on logarithmic paper, the form may appear as a straight line with a reduced heterogeneity of variance. The coefficients of the resulting log linear model can be estimated by the method of least squares.

To provide comparative statistics, the tables incorporating logarithmic models include expressions of mean error, average bias, and average deviations, all expressed in percentage. These expressions indicate the relative reliability of the tables with which they are associated.

Percent average is obtained as follows:

$$100(\Sigma\ \hat{Y}i - \Sigma\ Yi)/\Sigma\ \hat{Y}i = 100\ (\hat{\bar{Y}} - \bar{Y})/\hat{\bar{Y}}$$

where $\Sigma\ Yi$ = sum of arithmetic estimates

$\Sigma\ Yi$ = sum of observations

$\hat{\bar{Y}}$ = mean of arithmetic estimates

$\bar{Y}$ = mean of observations

Mean error, expressed in percentage, is an indication of the average variation of the sample. Expressing the deviation in percentage tends to overcome the inherent problem of heterogeneous variance. The procedure for calculating the mean error is:

$$\left[\sum_{i=1}^{n} \Big((Yi - \hat{Y}i)100/\hat{Y}i\Big)^2/n\text{-}k\text{-}1\right]^{\frac{1}{2}}$$

where Yi - observed value

$\hat{Y}i$ = arithmetic estimated value

n - number of observations in the data set

k = number of independent variables in the model

Inasmuch as bias is included in the calculation, the value obtained is always somewhat larger than if an unbiased procedure had been used initially. From an interpretive standpoint, the percent mean error is analogous to the usual standard error (deviation) of regression.

Although not appropriate from a purely statistical sense, average percent deviation provides an estimate of the average deviation of the individual observations from their respective means. In the past the value has often accompanied volume tables to provide the user with a rough indication of variability. Average percent deviation is always less than mean error, being approximately 75 percent that of mean error, depending upon the magnitude of bias. Average deviation equals

$$\sum_{i=1}^{n} \left(\left|(Yi - \hat{Y}i)100/\hat{Y}i\right|\right)/n$$

Development of Stand Volume Tables

Stand volume tables are usually developed from multiple-stand samples. The tables included here are based upon single-stem volume equations which, when extended, provide the tabular values. The procedure used in the development of the equations consisted of regressing total stem volume against the product of basal area and total height for each tree. The intercept term was dropped and the regression coefficient was used as an estimate of cylindrical form factor. Because the form factor decreases with increasing d.b.h., the factor used to develop the tables represents those trees in the diameter class interval of 4 to 10 inches. The tabular values are obtained by the formula:

$$V = KBH$$

where V = total stand volume

K = form factor

BH = basal area of the stand multiplied by the average height of the trees sampled for basal area.

The factors for the four species are:

Species	*Factor*
Ponderosa pine	0.36
Western larch	.36
Douglas-fir	.40
Lodgepole pine	.46

The only published stand volume tables existing for the species and locale involved in this study are for lodgepole pine (Cole 1971). A comparison between the two tables shows remarkable agreement, suggesting that the approach used here is worthy of application for the other species until such time as conventional stand volume tables are developed.

TABLES FOR VOLUME ESTIMATION

The Tables

In the appendix of this paper, volume estimation tables are presented for four species--ponderosa pine, lodgepole pine, western larch, and Douglas-fir. In all tables, diameter classes indicated are based on midpoint measurements; e.g., the 6-inch class includes trees 5.5 through 6.4 inches in diameter. The tables include:

1. *Standard volume tables:*--These tables contain estimates of total gross cubic-foot wood volume for the entire stem, inside bark, including stump and top. They are intended for use as standard volume tables.

2. *Top volume tables*.--Top volume tables are included for specified minimum top diameters, inside bark, from 2 to 8 inches. Top volume refers to total gross cubic-foot wood volume of the portion of the stem above the specified diameter. Additionally, where specified minimum top diameter approaches tree d.b.h., top volume is limited to that portion of the stem above an 8-foot "merchantable" stem section.

3. *Gross bark volume tables*.--Gross bark volume is the total cubic-foot volume of bark for the entire stem, including stump and top, without reduction for void space.

4. *Double bark thickness tables*.--These tables are included to aid in the estimation of wood and bark residue contained in pieces of the stem, rather than the entire stem or top. The estimates are based upon the inside and outside bark field measurements of the upper five tree segments.

5. *Stump diameter-d.b.h. relationship tables*.--These tables indicate the relationship between stump diameter, inside bark, and tree diameter at breast height, outside bark. They are useful in reconstructing stem or stand parameters from stump measurements.

6. *Stand volume tables*.--These tables contain estimates of the total cubic-foot volume of a stand (or component of a stand, such as a given story in a multistoried stand) in cubic feet per acre, for basal area and dominant tree average height corresponding to the stand or stand component for which basal area was obtained.

Applications and Limitations

Tables of the kind represented here are empirically developed, and the tabular values are estimated averages for each size class. The fact that the values are averages suggests that the tables are appropriate only when applied to relatively large numbers of observations within the range of the source data. The tabular values have been extended approximately two diameter and height classes beyond the range of the sample data. Extrapolation beyond the data range is ill advised, particularly toward the upper limits of the diameter classes because of the limited number of trees represented in those classes.

Users of the stand volume tables should be aware that, in multistoried or in mixed stands, volumes can be obtained by identifying and measuring each stand component, then summing these partial volumes to obtain the estimated total volume.

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Table 1.--*Total cubic volume, inside bark, including stump and top--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
2	0.17	0.23	0.30	0.40	0.53	0.70								21
3	0.40	0.52	0.67	0.86	1.11	1.44								22
4	0.72	0.92	1.17	1.49	1.89	2.41	3.06							38
5		1.44	1.81	2.28	2.86	3.59	4.50	5.65						23
6		2.08	2.59	3.22	4.00	4.97	6.17	7.67						12
7		2.84	3.50	4.31	5.31	6.54	8.06	9.93	12.23					12
8		3.72	4.54	5.56	6.79	8.31	10.16	12.42	15.19					13
9			5.72	6.95	8.44	10.25	12.45	15.13	18.37	22.32				15
10			7.03	8.49	10.25	12.38	14.94	18.05	21.79	26.31				20
11			8.47	10.17	12.22	14.67	17.62	21.17	25.42	30.54				12
12				12.00	14.34	17.14	20.49	24.49	29.27	34.98	41.81			23
13				13.97	16.62	19.78	23.53	28.00	33.32	39.64	47.17			17
14				16.08	19.05	22.58	26.75	31.70	37.56	44.51	52.74	62.49		20
15				18.33	21.64	25.54	30.14	35.58	42.00	49.57	58.51	69.06		24
16				20.72	24.37	28.66	33.71	39.64	46.62	54.83	64.48	75.84		25
17				23.25	27.25	31.94	37.44	43.88	51.43	60.28	70.65	82.80		21
18					30.28	35.37	41.33	48.28	56.41	65.91	77.00	89.96		13
19					33.45	38.96	45.38	52.86	61.57	71.71	83.53	97.29		12
20						42.70	49.59	57.60	66.90	77.70	90.24	104.81		12
21						46.59	53.96	62.50	72.39	83.85	97.12	112.49	130.29	4
22						50.63	58.49	67.56	78.05	90.17	104.17	120.34	139.02	2
23							63.16	72.78	83.87	96.65	111.38	128.35	147.90	1
24								78.16	89.85	103.30	118.75	136.52	156.94	0

Log V = -1.52198	+2.12327 (log D)	+0.0138002 (H)	-0.00561155 (log D) (H)
S.D. of coeff.	0.0231878	0.000552903	0.000420125

S.E. = 0.04413

Mean error = 10.5 percent
Ave. bias = -0.73 percent
Ave. deviation = 7.9 percent

Table 2.--*Top cubic volume, inside bark (2-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
3	0.077	0.099	0.114	0.126	0.136	0.145								19
4	0.052	0.071	0.085	0.096	0.106	0.115	0.123							38
5		0.055	0.068	0.078	0.088	0.097	0.105	0.112						23
6		0.045	0.056	0.066	0.075	0.084	0.091	0.098						12
7		0.037	0.048	0.058	0.066	0.074	0.081	0.088	0.095					12
8		0.032	0.042	0.051	0.059	0.067	0.074	0.080	0.087					13
9			0.037	0.046	0.053	0.061	0.067	0.074	0.080	0.087				15
10			0.034	0.041	0.049	0.056	0.062	0.069	0.075	0.081				20
11			0.030	0.038	0.045	0.052	0.058	0.064	0.070	0.076				12
12			0.029	0.035	0.042	0.048	0.054	0.061	0.066	0.072	0.078			23
13			0.026	0.033	0.039	0.045	0.051	0.057	0.063	0.069	0.074			17
14			0.024	0.030	0.037	0.043	0.049	0.054	0.060	0.066	0.071	0.076		20
15			0.022	0.028	0.035	0.040	0.046	0.052	0.057	0.063	0.068	0.073		24
16				0.027	0.033	0.038	0.044	0.049	0.055	0.060	0.066	0.071		25
17				0.025	0.031	0.037	0.042	0.047	0.053	0.058	0.063	0.068		21
18				0.024	0.030	0.035	0.040	0.046	0.051	0.056	0.061	0.066		13
19				0.023	0.028	0.033	0.039	0.044	0.049	0.054	0.059	0.064		12
20				0.022	0.027	0.032	0.037	0.042	0.047	0.052	0.057	0.062		12
21						0.031	0.036	0.041	0.046	0.051	0.056	0.061	0.666	4
22						0.030	0.035	0.040	0.044	0.049	0.054	0.059	0.064	2
23							0.034	0.038	0.043	0.048	0.053	0.057	0.062	1
24								0.037	0.042	0.047	0.051	0.056	0.061	0

Log V = -0.460586 -2.09688 (log D) +0.733094 (log D) (log H)
S.D. of coeff. 0.143811 0.0617454
S.E. = 0.08256

Mean error = 18.9 percent
Ave. bias = -2.4 percent
Ave. deviation = 14.3 percent

Table 3.--*Top cubic volume, inside bark (3-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
4	0.241	0.323	0.383	0.432	0.475	0.513	0.547							28
5		0.241	0.294	0.338	0.377	0.412	0.445	0.475						22
6		0.190	0.237	0.277	0.312	0.345	0.375	0.404						12
7		0.155	0.197	0.233	0.266	0.297	0.325	0.352	0.377					12
8		0.130	0.168	0.202	0.232	0.260	0.287	0.312	0.336					13
9			0.146	0.177	0.205	0.232	0.257	0.281	0.304	0.326				15
10			0.129	0.158	0.184	0.209	0.233	0.256	0.278	0.299				20
11			0.115	0.142	0.167	0.191	0.213	0.235	0.256	0.277				12
12			0.104	0.129	0.153	0.175	0.197	0.218	0.238	0.258	0.277			23
13			0.094	0.118	0.140	0.162	0.183	0.203	0.222	0.241	0.260			17
14			0.086	0.109	0.130	0.151	0.170	0.190	0.208	0.227	0.245	0.263		20
15			0.080	0.101	0.121	0.141	0.160	0.178	0.197	0.214	0.232	0.249		24
16				0.094	0.113	0.132	0.151	0.168	0.186	0.203	0.220	0.237		25
17				0.088	0.106	0.125	0.142	0.160	0.177	0.193	0.210	0.226		21
18				0.082	0.100	0.118	0.135	0.152	0.168	0.184	0.201	0.217		13
19				0.078	0.095	0.112	0.128	0.145	0.161	0.176	0.192	0.208		12
20				0.073	0.090	0.106	0.122	0.138	0.154	0.169	0.184	0.200		12
21						0.101	0.117	0.132	0.147	0.163	0.177	0.192	0.207	4
22						0.097	0.112	0.127	0.142	0.156	0.171	0.186	0.200	2
23							0.107	0.122	0.136	0.151	0.165	0.179	0.194	1
24								0.117	0.132	0.146	0.160	0.174	0.188	0

Log V = 0.299133 -2.22255 (log D) +0.699746 (log D) (log H)
S.D. of coeff. 0.141233 0.05960
S.E. = 0.07406

Mean error = 16.6 percent
Ave. bias = -2.1 percent
Ave. deviation = 13.0 percent

Table 4.--*Top cubic volume, inside bark (4-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet)													Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	130	
	Cubic feet													*No. trees*
5		0.770	0.910	1.025	1.124	1.212	1.291	1.364						12
6		0.600	0.723	0.825	0.914	0.994	1.067	1.134						11
7		0.486	0.595	0.687	0.768	0.841	0.908	0.971	1.029					12
8		0.405	0.502	0.586	0.660	0.727	0.790	0.848	0.903					13
9			0.433	0.509	0.577	0.640	0.698	0.753	0.804	0.853				15
10			0.379	0.449	0.512	0.571	0.625	0.676	0.725	0.772				20
11			0.336	0.401	0.460	0.515	0.566	0.614	0.660	0.705				12
12			0.301	0.362	0.417	0.468	0.517	0.562	0.606	0.648	0.689			23
13			0.272	0.329	0.381	0.429	0.475	0.519	0.560	0.601	0.640			17
14			0.247	0.301	0.350	0.396	0.440	0.481	0.521	0.560	0.597	0.633		20
15			0.227	0.277	0.324	0.367	0.409	0.449	0.487	0.524	0.560	0.595		24
16				0.257	0.301	0.343	0.382	0.420	0.457	0.493	0.527	0.561		25
17				0.239	0.281	0.321	0.359	0.395	0.431	0.465	0.498	0.531		21
18				0.223	0.263	0.301	0.338	0.373	0.407	0.440	0.472	0.504		13
19				0.209	0.248	0.284	0.319	0.353	0.386	0.418	0.449	0.480		12
20				0.197	0.234	0.269	0.303	0.335	0.367	0.398	0.428	0.458		12
21						0.255	0.288	0.319	0.350	0.380	0.409	0.438	0.466	4
22						0.242	0.274	0.305	0.334	0.363	0.392	0.420	0.447	2
23							0.261	0.291	0.320	0.348	0.376	0.403	0.430	1
24								0.279	0.307	0.334	0.361	0.388	0.414	0

Log V = 0.842466	-2.13641 (log D)	+0.59070 (log D) (log H)
S.D. of coeff.	0.162516	0.065958

S.E. = 0.07579

Mean error = 17.1 percent
Ave. bias = -2.1 percent
Ave. deviation = 12.9 percent

Table 5.--*Top cubic volume, inside bark (5-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
6		1.390	1.674	1.910	2.116	2.301	2.470	2.626						2
7		1.113	1.362	1.572	1.757	1.924	2.078	2.221	2.355					11
8		0.918	1.139	1.328	1.496	1.648	1.789	1.921	2.046					13
9			0.973	1.145	1.298	1.438	1.568	1.691	1.807	1.917				15
10			0.846	1.002	1.143	1.273	1.394	1.508	1.616	1.720				20
11			0.744	0.888	1.019	1.139	1.253	1.360	1.462	1.559				12
12			0.663	0.796	0.917	1.030	1.136	1.237	1.333	1.426	1.515			23
13			0.595	0.719	0.833	0.939	1.039	1.134	1.225	1.313	1.398			17
14			0.539	0.655	0.762	0.862	0.956	1.046	1.133	1.217	1.298	1.376		20
15			0.492	0.600	0.701	0.795	0.885	0.971	1.054	1.134	1.211	1.286		24
16				0.553	0.648	0.738	0.823	0.905	0.984	1.061	1.135	1.207		25
17				0.513	0.603	0.688	0.769	0.848	0.923	0.997	1.068	1.138		21
18				0.477	0.563	0.644	0.722	0.797	0.869	0.940	1.008	1.076		13
19				0.445	0.517	0.605	0.679	0.751	0.821	0.889	0.955	1.020		12
20				0.417	0.495	0.570	0.641	0.711	0.778	0.843	0.907	0.970		12
21						0.538	0.607	0.674	0.739	0.802	0.864	0.924	0.984	4
22						0.510	0.576	0.641	0.703	0.764	0.824	0.883	0.941	2
23							0.548	0.610	0.671	0.730	0.788	0.845	0.902	1
24								0.583	0.642	0.699	0.755	0.811	0.865	0

Log V = 1.26403 -2.20809 (log D) +0.58980 (log D) (log H)
S.D. of coeff. 0.155923 0.0615612
S.E. = 0.06761

Mean error = 15.7 percent
Ave. bias = -1.5 percent
Ave. deviation = 12.2 percent

Table 6.--*Top cubic volume, inside bark (6-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
7			2.716	3.236	3.706	4.141	4.548	4.933	5.299					1
8			2.187	2.637	3.048	3.432	3.794	4.138	4.467					7
9			1.806	2.201	2.566	2.908	3.233	3.543	3.842	4.130				15
10			1.523	1.873	2.199	2.507	2.802	3.084	3.357	3.621				20
11			1.304	1.618	1.913	2.193	2.461	2.720	2.971	3.216				12
12			1.132	1.416	1.684	1.940	2.187	2.426	2.658	2.885	3.107			23
13			0.994	1.252	1.498	1.734	1.962	2.183	2.399	2.611	2.818			17
14			0.882	1.118	1.344	1.562	1.774	1.980	2.182	2.381	2.575	2.767		20
15			0.788	1.006	1.215	1.417	1.615	1.808	1.998	2.184	2.368	2.549		24
16				0.911	1.105	1.294	1.479	1.661	1.840	2.015	2.189	2.360		25
17				0.830	1.011	1.189	1.363	1.534	1.702	1.869	2.033	2.196		21
18				0.760	0.930	1.097	1.261	1.422	1.582	1.740	1.897	2.052		13
19				0.700	0.859	1.017	1.171	1.325	1.476	1.627	1.776	1.924		12
20				0.647	0.797	0.946	1.093	1.238	1.383	1.526	1.668	1.810		12
21						0.883	1.023	1.161	1.299	1.436	1.572	1.708	1.843	4
22						0.827	0.960	1.092	1.224	1.355	1.486	1.616	1.746	2
23							0.904	1.030	1.156	1.282	1.407	1.533	1.658	1
24								0.974	1.095	1.216	1.336	1.457	1.577	0

Log V = 1.80585   -2.68641 (log D)   +0.719723 (log D) (log H)
S.D. of coeff.   0.175437   0.0696747
S.E. = 0.07392

Mean error = 17.5 percent
Ave. bias = -1.9 percent
Ave. deviation = 13.6 percent

Table 7.--*Top cubic volume, inside bark (7-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
8			3.970	4.888	5.744	6.553	7.326	8.069	8.786					0
9			3.182	3.964	4.701	5.404	6.079	6.733	7.367	7.984				8
10			2.610	3.287	3.930	4.548	5.145	5.726	6.292	6.846				18
11			2.183	2.774	3.342	3.891	4.424	4.945	5.456	5.957				12
12			1.853	2.377	2.882	3.374	3.855	4.326	4.790	5.246	5.697			23
13			1.595	2.061	2.515	2.959	3.396	3.825	4.249	4.668	5.082			17
14			1.387	1.807	2.217	2.621	3.020	3.413	3.803	4.189	4.572	4.952		20
15			1.217	1.598	1.972	2.341	2.707	3.070	3.430	3.788	4.144	4.497		24
16				1.425	1.767	2.107	2.444	2.780	3.114	3.447	3.779	4.110		25
17				1.279	1.594	1.907	2.220	2.533	2.844	3.155	3.466	3.776		21
18				1.156	1.446	1.737	2.028	2.320	2.611	2.903	3.195	3.487		13
19				1.050	1.319	1.590	1.862	2.135	2.408	2.683	2.958	3.233		12
20				0.958	1.209	1.462	1.716	1.973	2.230	2.489	2.749	3.010		12
21						1.350	1.589	1.830	2.073	2.318	2.564	2.811	3.060	4
22						1.251	1.476	1.704	1.934	2.166	2.399	2.635	2.871	2
23						1.163	1.376	1.591	1.809	2.030	2.252	2.476	2.702	1
24						1.085	1.286	1.491	1.698	1.907	2.119	2.333	2.549	0

Log V = 2.29514 -3.06128 (log D) +0.800789 (log D) (log H)
S.D. of coeff. 0.18462 0.074664
S.E. = 0.07433

Mean error = 17.4 percent
Ave. bias = -2.0 percent
Ave. deviation = 13.5 percent

Table 8.--*Top cubic volume, inside bark (8-inch top diameter)--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
9			4.993	6.332	7.614	8.852	10.054	11.227	12.375	13.500				2
10			4.051	5.196	6.304	7.382	8.436	9.470	10.486	11.488				9
11			3.352	4.345	5.314	6.263	7.197	8.118	9.028	9.927				12
12			2.821	3.691	4.546	5.391	6.226	7.053	7.874	8.688	9.498			23
13			2.406	3.176	3.939	4.696	5.448	6.197	6.943	7.686	8.426			17
14			2.077	2.764	3.449	4.133	4.816	5.498	6.180	6.861	7.541	6.229		20
15			1.811	2.428	3.047	3.669	4.293	4.918	5.545	6.173	6.802	7.432		24
16				2.151	2.714	3.283	3.855	4.431	5.010	5.591	6.176	6.762		25
17				1.920	2.435	2.957	3.485	4.017	4.555	5.096	5.640	6.188		21
18				1.724	2.198	2.679	3.168	3.663	4.163	4.668	5.178	5.691		13
19				1.558	1.995	2.441	2.895	3.357	3.824	4.297	4.775	5.258		12
20				1.415	1.819	2.234	2.658	3.090	3.528	3.972	4.423	4.878		12
21					1.667	2.054	2.451	2.855	3.267	3.686	4.111	4.542	4.978	4
22						1.896	2.268	2.649	3.037	3.433	3.835	4.243	4.657	2
23							2.106	2.465	2.832	3.207	3.588	3.976	4.369	1
24								2.301	2.649	3.004	3.367	3.736	4.111	0

Log V = 2.59226	-3.26371 (log D)	+0.865846 (log D) (log H)
S.D. of coeff.	0.163612	0.0656584

S.E. = 0.06339

Mean error = 15.0 percent
Ave. bias = -1.3 percent
Ave. deviation = 11.5 percent

Table 9.--*Gross cubic bark volume, entire stem--ponderosa pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
2	0.03	0.05	0.07	0.09	0.10	0.12								21
3	0.07	0.12	0.16	0.20	0.23	0.27								22
4	0.12	0.21	0.28	0.35	0.42	0.48	0.55							38
5	0.18	0.32	0.44	0.55	0.66	0.76	0.86	0.96						23
6	0.26	0.45	0.63	0.80	0.96	1.11	1.26	1.40						12
7	0.34	0.61	0.85	1.09	1.31	1.52	1.73	1.93	2.13					12
8	0.44	0.79	1.11	1.42	1.71	2.00	2.28	2.55	2.82					13
9		0.99	1.41	1.80	2.18	2.55	2.91	3.26	3.60	3.94				15
10		1.22	1.73	2.22	2.70	3.16	3.61	4.05	4.49	4.92				20
11			2.09	2.69	3.27	3.84	4.40	4.94	5.48	6.01				12
12				3.21	3.91	4.59	5.26	5.92	6.57	7.21	7.84			23
13				3.77	4.60	5.41	6.20	6.99	7.76	8.53	9.28			17
14				4.37	5.34	6.29	7.23	8.15	9.06	9.96	10.85	11.73		20
15				5.02	6.15	7.25	8.33	9.41	10.46	11.51	12.55	13.58		24
16				5.72	7.01	8.27	9.52	10.75	11.97	13.18	14.38	15.56		25
17				6.46	7.92	9.37	10.79	12.20	13.59	14.97	16.33	17.69		21
18					8.90	10.53	12.14	13.73	15.31	16.87	18.42	19.96		13
19					9.93	11.76	13.57	15.36	17.14	18.90	20.65	22.38		12
20						13.07	15.09	17.09	19.07	21.04	23.00	24.94	26.88	12
21						14.44	16.69	18.91	21.12	23.31	25.49	27.66	29.81	4
22						15.88	18.37	20.83	23.27	25.70	28.11	30.51	32.90	2
23						17.40	20.13	22.84	25.53	28.21	30.87	33.52	36.16	1
24						18.98	21.98	24.95	27.91	30.84	33.77	36.68	39.57	0

Log V = -2.70154	+1.65961 (log D)	+0.648249 (log H)	+0.218658 (log D) (log H)
S.D. of coeff.	0.094535	0.048470	0.049889

S.E. = 0.06002

Mean error = 14.4 percent
Ave. bias = 0.72 percent
Ave. deviation = 10.5 percent

Table 10.--*Double bark thickness for stem sections of specified diameter--ponderosa pine*

D.o.b.	D.o.b. (10ths of inches)										D.o.b.
(inches)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	(inches)
	- - - - - - - - - -				-*Inches* - - - - - - - - -						
2	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.24	0.25	0.26	2
3	0.28	0.29	0.30	0.31	0.32	0.33	0.35	0.36	0.37	0.38	3
4	0.39	0.40	0.42	0.43	0.44	0.45	0.46	0.47	0.49	0.50	4
5	0.51	0.52	0.53	0.54	0.56	0.57	0.58	0.59	0.60	0.61	5
6	0.63	0.64	0.65	0.66	0.67	0.68	0.70	0.71	0.72	0.73	6
7	0.74	0.75	0.77	0.78	0.79	0.80	0.81	0.82	0.84	0.85	7
8	0.86	0.87	0.88	0.89	0.91	0.92	0.93	0.94	0.95	0.96	8
9	0.98	0.99	1.00	1.01	1.02	1.03	1.05	1.06	1.07	1.08	9
10	1.09	1.10	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	10
11	1.21	1.22	1.23	1.25	1.26	1.27	1.28	1.29	1.30	1.32	11
12	1.33	1.34	1.35	1.36	1.37	1.39	1.40	1.41	1.42	1.43	12
13	1.44	1.46	1.47	1.48	1.49	1.50	1.51	1.53	1.54	1.55	13
14	1.56	1.57	1.58	1.60	1.61	1.62	1.63	1.64	1.65	1.67	14
15	1.68	1.69	1.70	1.71	1.72	1.74	1.75	1.76	1.77	1.78	15
16	1.79	1.81	1.82	1.83	1.84	1.85	1.86	1.88	1.89	1.90	16
17	1.91	1.92	1.93	1.95	1.96	1.97	1.98	1.99	2.00	2.02	17
18	2.03	2.04	2.05	2.06	2.07	2.09	2.10	2.11	2.12	2.13	18
19	2.14	2.16	2.17	2.18	2.19	2.20	2.22	2.23	2.24	2.25	19
20	2.26	2.27	2.29	2.30	2.31	2.32	2.33	2.34	2.36	2.37	20

Values computed from the single-bark-thickness equation:

T = -0.0376115 +0.0584243 (D.o.b.)
S.D. of coeff. 0.00044242
S.E. = 0.080279
R^2 = 0.906
N = 1,810

Table 11.--*Total cubic volume, inside bark, including stump and top--lodgepole pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	- - -	- - -	- - -	- - -	- - -	- - -	*Cubic feet*	- - -	- - -	- - -	- - -	- - -	*No. trees*
2	0.12	0.24	0.35	0.46	0.57	0.68	0.79						17
3	0.27	0.52	0.77	1.01	1.25	1.50	1.74						18
4		0.90	1.34	1.76	2.18	2.60	3.02	3.43					23
5		1.39	2.05	2.71	3.36	4.00	4.64	5.28					16
6		1.97	2.92	3.85	4.77	5.69	6.60	7.50					8
7			3.92	5.18	6.42	7.65	8.88	10.10	11.31	12.52			13
8			5.08	6.70	8.30	9.90	11.48	13.06	14.63	16.19			16
9			6.37	8.40	10.42	12.42	14.41	16.39	18.35	20.31	22.27		23
10			7.80	10.29	12.76	15.21	17.65	20.07	22.48	24.89	27.28		23
11				12.37	15.34	18.28	21.21	24.12	27.02	29.90	32.78		12
12					18.14	21.62	25.08	28.52	31.95	35.36	38.76		24
13					21.16	25.22	29.26	33.28	37.28	41.26	45.23		10
14					24.41	29.09	33.75	38.38	43.00	47.59	52.17		10
15					27.88	33.23	38.55	43.84	49.11	54.36	59.58		6
16					31.57	37.63	43.65	49.65	55.61	61.55	67.47	73.37	2
17					35.48	42.29	49.06	55.80	62.50	69.18	75.83	82.46	5
18					39.61	47.22	54.77	62.29	69.78	77.23	84.66	92.06	1
19					43.96	52.40	60.79	69.13	77.44	85.71	93.96	102.17	0
20						57.84	67.10	76.31	85.48	94.62	103.72	112.78	0

Log V = -0.2771 +0.963354 (log (Basal Area × Height))
S.D. of coeff. 0.0042446
S.E. = 0.04512

Mean error = 10.1 percent
Ave. bias = -0.50 percent
Ave. deviation = 7.9 percent

Table 12.--*Top cubic volume, inside bark (2-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
3	0.074	0.099	0.117	0.132	0.144	0.156	0.166						21
4		0.067	0.083	0.096	0.108	0.119	0.129	0.138					23
5		0.050	0.064	0.076	0.087	0.097	0.106	0.115					16
6		0.039	0.051	0.062	0.072	0.082	0.091	0.099					8
7			0.043	0.053	0.062	0.071	0.079	0.088	0.095	0.103			13
8			0.036	0.046	0.054	0.063	0.071	0.079	0.086	0.094			16
9			0.032	0.040	0.048	0.056	0.064	0.071	0.079	0.086	0.093		23
10			0.028	0.036	0.044	0.051	0.058	0.065	0.072	0.079	0.086		23
11				0.032	0.040	0.047	0.054	0.060	0.067	0.074	0.081		12
12					0.036	0.043	0.050	0.056	0.063	0.069	0.076		24
13					0.034	0.040	0.046	0.053	0.059	0.065	0.072		10
14					0.031	0.037	0.043	0.050	0.056	0.062	0.068		10
15					0.029	0.035	0.041	0.047	0.053	0.059	0.065		6
16					0.027	0.033	0.039	0.045	0.050	0.056	0.062	0.068	2
17						0.031	0.037	0.042	0.048	0.054	0.060	0.065	5
18						0.030	0.035	0.040	0.046	0.052	0.057	0.063	1
19						0.028	0.033	0.039	0.044	0.050	0.055	0.061	0
20						0.027	0.032	0.037	0.042	0.048	0.053	0.059	0

Log V = -0.365736   -2.46962 (log D)   +0.86752 (log D) (log H)
S.D. of coeff.   0.248634   0.111916
S.E. = 0.08814

Mean error = 21.8 percent
Ave. bias = -3.07 percent
Ave. deviation = 16.7 percent

Table 13.--*Top cubic volume, inside bark (3-inch top diameter)--lodgepole pine*

D.b.h. (Inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
4		0.305	0.369	0.422	0.469	0.510	0.549	0.584					24
5		0.219	0.273	0.319	0.361	0.398	0.433	0.466					16
6		0.167	0.214	0.254	0.291	0.325	0.357	0.387					8
7			0.174	0.210	0.243	0.274	0.304	0.331	0.358	0.384			13
8			0.145	0.178	0.208	0.236	0.264	0.290	0.315	0.339			16
9			0.124	0.153	0.181	0.207	0.233	0.257	0.281	0.303	0.326		23
10			0.108	0.135	0.160	0.185	0.208	0.231	0.253	0.275	0.296		23
11				0.119	0.143	0.166	0.188	0.210	0.231	0.251	0.272		12
12					0.129	0.151	0.172	0.192	0.212	0.232	0.251		24
13					0.118	0.138	0.158	0.177	0.196	0.215	0.234		10
14					0.108	0.127	0.146	0.164	0.183	0.201	0.218		10
15					0.100	0.118	0.136	0.153	0.171	0.188	0.205		6
16					0.092	0.110	0.127	0.144	0.160	0.177	0.194	0.210	2
17						0.102	0.119	0.135	0.151	0.167	0.183	0.199	5
18						0.096	0.112	0.127	0.143	0.158	0.174	0.189	1
19						0.091	0.106	0.121	0.136	0.151	0.166	0.181	0
20						0.086	0.100	0.114	0.129	0.144	0.158	0.173	0

Log V = 0.376276 -2.49626 (log D) +0.779565 (log D) (log H)
S.D. of coeff. 0.29006 0.127401
S.E. = 0.09303

Mean error = 22.3 percent
Ave. bias = -3.31 percent
Ave. deviation = 17.5 percent

Table 14.--*Top cubic volume, inside bark (4-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	- - -	- - -	- - -	- - -	- - -	- - -	*Cubic feet*	- - -	- - -	- - -	- - -	- - -	*No. trees*
5		0.630	0.777	0.902	1.012	1.113	1.205	1.291					16
6		0.477	0.603	0.712	0.810	0.900	0.983	1.062					8
7			0.487	0.583	0.671	0.752	0.828	0.900	0.969	1.035			13
8			0.405	0.491	0.570	0.644	0.713	0.780	0.844	0.906			16
9			0.344	0.421	0.493	0.561	0.626	0.688	0.747	0.805	0.861		23
10			0.297	0.367	0.433	0.496	0.556	0.614	0.670	0.725	0.778		23
11				0.325	0.386	0.444	0.500	0.555	0.607	0.659	0.709		12
12					0.347	0.401	0.454	0.505	0.555	0.604	0.652		24
13					0.314	0.366	0.415	0.464	0.511	0.557	0.603		10
14					0.287	0.335	0.382	0.428	0.473	0.518	0.561		10
15					0.264	0.309	0.354	0.398	0.441	0.483	0.525		6
16					0.244	0.287	0.329	0.371	0.412	0.453	0.493	0.533	2
17						0.267	0.308	0.348	0.387	0.426	0.465	0.503	5
18						0.250	0.289	0.327	0.365	0.402	0.440	0.477	1
19						0.235	0.272	0.309	0.345	0.381	0.417	0.453	0
20						0.221	0.257	0.292	0.327	0.362	0.397	0.432	0

Log V = 0.860507 -2.48286 (log D) +0.741235 (log D) (log H)
S.D. of coeff. 0.295097 0.129431
S.E. = 0.08588

Mean error = 20.6 percent
Ave. bias = -2.69 percent
Ave. deviation = 15.5 percent

Table 15.--*Top cubic volume, inside bark (5-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
6		1.133	1.422	1.672	1.894	2.098	2.288	2.466					6
7			1.135	1.353	1.550	1.732	1.903	2.064	2.217	2.364			13
8			0.934	1.126	1.303	1.467	1.622	1.769	1.910	2.046			16
9			0.786	0.958	1.117	1.267	1.409	1.544	1.674	1.800	1.922		23
10			0.674	0.829	0.974	1.111	1.242	1.367	1.488	1.606	1.720		23
11				0.728	0.861	0.987	1.108	1.225	1.338	1.448	1.555		12
12					0.768	0.885	0.998	1.108	1.214	1.318	1.419		24
13					0.692	0.801	0.907	1.010	1.110	1.208	1.304		10
14					0.629	0.731	0.830	0.927	1.022	1.115	1.206		10
15					0.575	0.671	0.764	0.856	0.946	1.034	1.121		6
16					0.528	0.619	0.708	0.795	0.880	0.964	1.048	1.130	2
17						0.574	0.658	0.741	0.822	0.903	0.983	1.062	5
18						0.535	0.615	0.693	0.771	0.849	0.925	1.001	1
19						0.500	0.576	0.652	0.726	0.800	0.874	0.947	0
20						0.469	0.542	0.614	0.686	0.757	0.828	0.898	0

Log V = 1.29058 -2.52686 (log D) +0.720985 (log D) (log H)
S.D. of coeff. 0.286708 0.130059
S.E. = 0.07350

Mean error = 17.4 percent
Ave. bias = -1.79 percent
Ave. deviation = 13.7 percent

Table 16.--*Top cubic volume, inside bark (6-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	Cubic feet												*No. trees*
7			2.337	2.845	3.315	3.756	4.174	4.574	4.958	5.329			11
8			1.844	2.275	2.679	3.061	3.427	3.779	4.119	4.449			16
9			1.495	1.868	2.220	2.556	2.880	3.193	3.498	3.794	4.085		23
10			1.241	1.566	1.877	2.176	2.465	2.747	3.022	3.291	3.555		23
11				1.335	1.612	1.880	2.141	2.397	2.647	2.893	3.136		12
12					1.403	1.646	1.883	2.116	2.346	2.573	2.796		24
13					1.235	1.456	1.673	1.888	2.099	2.309	2.516		10
14					1.097	1.300	1.500	1.698	1.894	2.089	2.282		10
15					0.983	1.170	1.355	1.538	1.721	1.903	2.084		6
16					0.887	1.060	1.231	1.403	1.574	1.744	1.914	2.084	2
17						0.966	1.126	1.286	1.447	1.607	1.767	1.927	5
18						0.885	1.035	1.185	1.336	1.487	1.639	1.791	1
19						0.814	0.955	1.097	1.240	1.383	1.526	1.670	0
20						0.753	0.886	1.020	1.154	1.290	1.426	1.564	0

Log V = 1.86838 -2.97158 (log D) +0.810267 (log D) (log H)
S.D. of coeff. 0.279111 0.127879
S.E. = 0.06773

Mean error = 16.0 percent
Ave. bias = -1.50 percent
Ave. deviation = 12.9 percent

Table 17.--*Top cubic volume, inside bark (7-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	Cubic feet												*No. trees*
8			3.195	4.083	4.938	5.768	6.578	7.371	8.149	8.915			17
9			2.508	3.249	3.972	4.681	5.378	6.065	6.744	7.415	8.080		23
10			2.019	2.649	3.270	3.883	4.492	5.095	5.694	6.289	6.881		23
11				2.202	2.742	3.280	3.816	4.351	4.885	5.418	5.950		12
12					2.334	2.811	3.289	3.768	4.248	4.729	5.211		24
13					2.014	2.439	2.868	3.300	3.735	4.173	4.612		10
14					1.756	2.139	2.527	2.919	3.316	3.716	4.119		10
15					1.546	1.892	2.245	2.604	2.968	3.336	3.708		6
16					1.372	1.688	2.011	2.340	2.675	3.016	3.361	3.710	2
17						1.516	1.813	2.117	2.427	2.743	3.064	3.390	5
18						1.370	1.644	1.926	2.214	2.508	2.808	3.113	1
19						1.244	1.499	1.761	2.030	2.305	2.586	2.872	0
20						1.136	1.373	1.618	1.869	2.127	2.391	2.661	0

Log V = 2.36229 -3.45108 (log D) +0.943681 (log D) (log H)
S.D. of coeff. 0.282235 0.129594
S.E. = 0.06524

Mean error = 15.2 percent
Ave. bias = -1.18 percent
Ave. deviation = 12.1 percent

Table 18.--*Top cubic volume, inside bark (8-inch top diameter)--lodgepole pine*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	*Cubic feet*	- - - -	- - - -	- - - -	- - - -	- - - -	*No. trees*
9			4.403	5.645	6.846	8.014	9.156	10.276	11.377	12.462	13.532		23
10			3.505	4.548	5.567	6.566	7.550	8.520	9.479	10.428	11.368		23
11				3.741	4.617	5.483	6.341	7.192	8.036	8.876	9.711		12
12					3.892	4.651	5.407	6.160	6.912	7.662	8.410		24
13					3.326	3.997	4.670	5.343	6.017	6.692	7.367		10
14					2.875	3.474	4.077	4.683	5.292	5.904	6.518		10
15					2.511	3.049	3.593	4.142	4.696	5.254	5.815		6
16						2.699	3.193	3.693	4.199	4.710	5.226	5.747	2
17						2.406	2.857	3.316	3.781	4.252	4.728	5.209	5
18						2.160	2.573	2.995	3.424	3.860	4.302	4.749	1
19						1.950	2.331	2.720	3.118	3.523	3.934	4.351	0
20						1.769	2.122	2.483	2.853	3.230	3.614	4.004	0

Log V = 2.70909 -3.50204 (log D) +0.905578 (log D) (log H)
S.D. of coeff. 0.282546 0.130545
S.E. = 0.06436

Mean error = 14.8 percent
Ave. bias = -1.06 percent
Ave. deviation = 11.6 percent

Table 19.--*Gross cubic bark volume, entire stem--lodgepole pine*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
2	0.02	0.04	0.06	0.07	0.09	0.11							17
3	0.03	0.06	0.10	0.13	0.16	0.19	0.23	0.27					18
4	0.04	0.09	0.14	0.19	0.24	0.29	0.35	0.41					23
5	0.05	0.12	0.19	0.26	0.34	0.41	0.48	0.58					16
6	0.05	0.16	0.25	0.34	0.44	0.53	0.63	0.76					8
7			0.30	0.42	0.54	0.67	0.80	0.93	1.06	1.29			13
8			0.37	0.51	0.66	0.82	0.98	1.14	1.30	1.59			16
9			0.43	0.60	0.78	0.97	1.16	1.36	1.56	1.77	2.20		23
10			0.49	0.70	0.91	1.13	1.36	1.60	1.84	2.08	2.61		23
11					1.04	1.30	1.57	1.84	2.13	2.42	3.04		12
12					1.18	1.48	1.79	2.11	2.43	2.77	3.11		24
13					1.33	1.67	2.02	2.38	2.75	3.13	3.52		10
14					1.48	1.86	2.25	2.66	3.08	3.51	3.96		10
15					1.63	2.06	2.50	2.95	3.42	3.91	4.41		6
16						2.26	2.75	3.26	3.78	4.32	4.88	5.45	2
17						2.47	3.01	3.57	4.15	4.75	5.36	6.00	5
18						2.69	3.28	3.89	4.53	5.19	5.87	6.56	1
19						2.91	3.55	4.23	4.92	5.64	6.39	7.15	0
20						3.14	3.84	4.57	5.33	6.11	6.92	7.75	0

Log V = -2.88644 +0.817021 (log D) +0.826817 (log H) +0.367366 (log D) (log H)
S.D. of coeff. 0.227677 0.091488 0.121033
S.E. = 0.07913

Mean error = 19.0 percent
Ave. bias = -1.22 percent
Ave. deviation = 14.4 percent

Table 20.--*Double bark thickness for stem sections of specified diameter--lodgepole pine*

D.o.b. (inches)	D.o.b. (10ths of inches) 0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	D.o.b. (inches)
	Inches										
2	0.11	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.13	0.14	2
3	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.17	3
4	0.17	0.17	0.17	0.18	0.18	0.18	0.19	0.19	0.19	0.19	4
5	0.20	0.20	0.20	0.21	0.21	0.21	0.21	0.22	0.22	0.22	5
6	0.23	0.23	0.23	0.23	0.24	0.24	0.24	0.25	0.25	0.25	6
7	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.27	0.28	0.28	7
8	0.28	0.29	0.29	0.29	0.29	0.30	0.30	0.30	0.31	0.31	8
9	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.33	0.33	0.34	9
10	0.34	0.34	0.35	0.35	0.35	0.35	0.36	0.36	0.36	0.37	10
11	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.39	0.39	11
12	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.42	0.42	0.42	12
13	0.43	0.43	0.43	0.43	0.44	0.44	0.44	0.45	0.45	0.45	13
14	0.45	0.46	0.46	0.46	0.47	0.47	0.47	0.47	0.48	0.48	14
15	0.48	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.51	0.51	15
16	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.53	0.53	0.54	16
17	0.54	0.54	0.55	0.55	0.55	0.55	0.56	0.56	0.56	0.57	17
18	0.57	0.57	0.57	0.58	0.58	0.58	0.59	0.59	0.59	0.59	18

Values computed from the single-bark-thickness equation:

T = 0.0271161 + 0.0142837 (D.o.b.)
S.D. of coeff. 0.000378354
S.E. = 0.0402561
R^2 = 0.556
N = 1,135

Table 21.--*Total cubic volume, inside bark, including stump and top--western larch*

D.b.h. (inches)	Total height (feet)													Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	130	
	Cubic feet													*No. trees*
2	0.11	0.21	0.30	0.40	0.49	0.59								17
3	0.23	0.45	0.66	0.86	1.06	1.27								20
4	0.40	0.77	1.13	1.49	1.84	2.18	2.53							18
5		1.18	1.73	2.27	2.80	3.33	3.86	4.38						26
6		1.66	2.44	3.21	3.96	4.71	5.45	6.18						17
7			3.27	4.29	5.31	6.31	7.30	8.29	9.26	10.24				16
8			4.21	5.53	6.83	8.12	9.40	10.67	11.93	13.19				14
9			5.26	6.92	8.54	10.16	11.76	13.34	14.92	16.49	18.05			18
10				8.45	10.44	12.40	14.36	16.30	18.22	20.13	22.04	23.93		18
11				10.12	12.50	14.86	17.20	19.52	21.83	24.12	26.41	28.68		20
12				11.93	14.75	17.53	20.29	23.03	25.75	28.45	31.14	33.82		23
13				13.89	17.16	20.40	23.61	26.80	29.97	33.12	36.25	39.37	42.47	23
14				15.99	19.75	23.48	27.18	30.84	34.49	38.11	41.72	45.31	48.88	10
15					22.51	26.76	30.98	35.16	39.31	43.44	47.55	51.64	55.71	7
16					25.45	30.25	35.01	39.73	44.43	49.10	53.74	58.36	62.97	4
17							39.27	44.58	49.84	55.08	60.29	65.47	70.64	3
18							43.77	49.68	55.55	61.39	67.19	72.97	78.73	1
19							48.50	55.04	61.55	68.01	74.45	80.85	87.23	1
20								60.67	67.84	74.96	82.05	89.11	96.14	2
21								66.55	74.41	82.23	90.01	97.75	105.46	1
22								72.69	81.28	89.82	98.31	106.77	115.19	0
23								79.08	88.42	97.72	106.96	116.16	125.32	0
24								85.73	95.86	105.93	115.95	125.92	135.85	0

Log V = -0.342917 +0.948258 (log (Basal Area × Height))
S.D. of coeff. 0.00361372
S.E. = 0.04018

Mean Error = 9.5 percent
Ave. Bias = -0.21 percent
Ave. Deviation = 7.0 percent

Table 22.--*Top cubic volume, inside bark (2-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
3	0.092	0.124	0.147	0.166	0.183	0.198								20
4	0.056	0.081	0.102	0.119	0.134	0.148	0.161							18
5		0.059	0.076	0.091	0.105	0.118	0.130	0.141						26
6		0.045	0.060	0.074	0.086	0.098	0.109	0.120						17
7			0.049	0.062	0.073	0.084	0.094	0.104	0.144	0.124				16
8			0.042	0.053	0.063	0.073	0.083	0.092	0.102	0.111				14
9				0.046	0.055	0.065	0.074	0.083	0.092	0.101	0.109			18
10				0.040	0.049	0.058	0.067	0.076	0.084	0.092	0.101	0.109		18
11				0.036	0.045	0.053	0.061	0.069	0.077	0.085	0.093	0.101		20
12				0.033	0.041	0.048	0.056	0.064	0.072	0.080	0.087	0.095		23
13				0.030	0.037	0.045	0.052	0.060	0.067	0.075	0.082	0.090	0.097	23
14				0.027	0.034	0.041	0.049	0.056	0.063	0.070	0.077	0.085	0.092	10
15					0.032	0.039	0.045	0.052	0.059	0.066	0.073	0.080	0.088	7
16					0.030	0.036	0.043	0.049	0.056	0.063	0.070	0.077	0.084	4
17							0.040	0.047	0.053	0.060	0.067	0.073	0.080	3
18							0.038	0.044	0.051	0.057	0.064	0.070	0.077	1
19							0.036	0.042	0.048	0.055	0.061	0.067	0.074	1
20								0.040	0.046	0.052	0.059	0.065	0.071	2
21								0.039	0.044	0.050	0.056	0.063	0.069	1
22								0.037	0.043	0.049	0.054	0.060	0.067	0
23								0.036	0.041	0.047	0.053	0.059	0.065	0
24								0.034	0.040	0.045	0.051	0.057	0.063	0

Log V = -0.218386 -2.61784 (log D) +0.900808 (log D) (log H)
S.D. of coeff. 0.19533 0.08398
S.E. = 0.06500

Mean Error = 15.0 percent
Ave. Bias = -1.25 percent
Ave. Deviation = 12.1 percent

Table 23.--*Top cubic volume, inside bark (3-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet)													Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	130	
	Cubic feet													*No. trees*
4	0.220	0.336	0.429	0.511	0.585	0.653	0.717							16
5		0.227	0.303	0.371	0.434	0.493	0.550	0.604						26
6		0.166	0.227	0.285	0.339	0.392	0.442	0.491						17
7			0.179	0.228	0.276	0.322	0.368	0.412	0.455	0.498				16
8			0.145	0.188	0.231	0.272	0.313	0.354	0.394	0.434				14
9				0.159	0.197	0.235	0.272	0.310	0.347	0.384	0.420			18
10				0.137	0.171	0.206	0.240	0.275	0.309	0.344	0.379	0.413		18
11				0.119	0.151	0.182	0.214	0.246	0.279	0.311	0.344	0.377		20
12				0.105	0.134	0.163	0.193	0.223	0.254	0.285	0.316	0.347		23
13				0.094	0.120	0.148	0.175	0.204	0.233	0.262	0.291	0.321	0.352	23
14				0.084	0.109	0.134	0.161	0.187	0.215	0.242	0.271	0.299	0.328	10
15					0.099	0.123	0.148	0.173	0.199	0.226	0.253	0.280	0.308	7
16					0.091	0.114	0.137	0.161	0.186	0.211	0.237	0.263	0.290	4
17							0.127	0.150	0.174	0.198	0.223	0.248	0.274	3
18							0.119	0.141	0.163	0.187	0.211	0.235	0.260	1
19							0.112	0.132	0.154	0.177	0.200	0.223	0.248	1
20								0.125	0.146	0.167	0.190	0.213	0.236	2
21								0.118	0.138	0.159	0.181	0.203	0.226	1
22								0.112	0.132	0.152	0.173	0.194	0.216	0
23								0.107	0.125	0.145	0.165	0.186	0.208	0
24								0.102	0.120	0.139	0.158	0.179	0.200	0

Log V = 0.574917 -3.0534 (log D) +1.00746 (log D) (log H)
S.D. of coeff. 0.23626 0.098734
S.E. = 0.06969

Mean Error = 15.8 percent
Ave. Bias = -1.37 percent
Ave. Deviation = 12.6 percent

Table 24.--*Top cubic volume, inside bark (4-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet)													Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	130	
	Cubic feet													*No. trees*
5		0.668	0.902	1.117	1.318	1.508	1.691	1.867						18
6		0.466	0.651	0.826	0.993	1.154	1.311	1.464						17
7			0.494	0.640	0.782	0.921	1.057	1.192	1.325	1.456				16
8			0.389	0.513	0.635	0.757	0.877	0.997	1.116	1.235				14
9				0.422	0.529	0.637	0.744	0.852	0.960	1.068	1.177			18
10				0.355	0.450	0.546	0.643	0.740	0.839	0.938	1.038	1.139		18
11				0.303	0.388	0.474	0.562	0.652	0.743	0.834	0.927	1.021		20
12				0.262	0.339	0.417	0.498	0.580	0.664	0.750	0.836	0.924		23
13				0.230	0.299	0.371	0.445	0.522	0.600	0.679	0.760	0.843	0.926	23
14				0.203	0.267	0.333	0.402	0.473	0.545	0.620	0.696	0.774	0.853	10
15					0.240	0.301	0.365	0.431	0.499	0.569	0.641	0.715	0.790	7
16					0.217	0.274	0.333	0.395	0.460	0.526	0.594	0.664	0.735	4
17							0.306	0.365	0.425	0.488	0.553	0.619	0.688	3
18							0.283	0.338	0.395	0.455	0.516	0.580	0.645	1
19							0.262	0.314	0.369	0.426	0.484	0.545	0.608	1
20								0.294	0.345	0.399	0.456	0.514	0.574	2
21								0.275	0.324	0.376	0.430	0.486	0.544	1
22								0.258	0.306	0.355	0.407	0.461	0.516	0
23								0.244	0.289	0.336	0.386	0.438	0.491	0
24								0.230	0.273	0.319	0.367	0.417	0.469	0

Log V = 1.20417 -3.35498 (log D) +1.06157 (log D) (log H)
S.D. of coeff. 0.242998 0.100253
S.E. = 0.06686

Mean Error = 15.0 percent
Ave. Bias = -1.25 percent
Ave. Deviation = 11.6 percent

Table 25.--*Top cubic volume, inside bark (5-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
6		1.183	1.633	2.053	2.452	2.835	3.205	3.565						7
7			1.212	1.555	1.886	2.207	2.522	2.831	3.134	3.433				16
8			0.937	1.222	1.502	1.777	2.049	2.318	2.584	2.848				14
9				0.988	1.228	1.468	1.766	1.943	2.180	2.416	2.652			18
10				0.817	1.026	1.237	1.448	1.660	1.872	2.085	2.299	2.513		18
11				0.688	0.872	1.059	1.248	1.439	1.632	1.825	2.020	2.217		20
12				0.588	0.752	0.920	1.090	1.264	1.439	1.616	1.796	1.977		23
13				0.509	0.656	0.808	0.963	1.121	1.282	1.445	1.611	1.779	1.949	23
14				0.445	0.578	0.716	0.858	1.003	1.152	1.303	1.457	1.614	1.772	10
15					0.514	0.640	0.771	0.905	1.043	1.183	1.327	1.474	1.623	7
16					0.461	0.576	0.697	0.822	0.950	1.081	1.216	1.354	1.494	4
17							0.634	0.750	0.870	0.994	1.120	1.250	1.382	3
18							0.580	0.689	0.801	0.917	1.037	1.159	1.284	1
19							0.533	0.635	0.741	0.851	0.963	1.080	1.199	1
20								0.588	0.688	0.792	0.899	1.009	1.123	2
21								0.547	0.641	0.740	0.841	0.946	1.055	1
22								0.510	0.600	0.693	0.790	0.890	0.994	0
23								0.477	0.562	0.651	0.744	0.840	0.939	0
24								0.448	0.529	0.614	0.702	0.794	0.889	0

Log V = 1.71647	-3.44297 (log D)	+1.02285 (log D) (log H)
S.D. of coeff.	0.253695	0.103695

S.E. = 0.06533

Mean Error = 15.2 percent
Ave. Bias = -1.39 percent
Ave. Deviation = 11.4 percent

Table 26.--*Top cubic volume, inside bark (6-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
7			2.576	3.252	3.896	4.516	5.116	5.700	6.271	6.829				5
8			1.968	2.524	3.062	3.585	4.097	4.599	5.092	5.578				13
9				2.019	2.476	2.925	3.368	3.805	4.238	4.666	5.091			18
10				1.653	2.047	2.438	2.826	3.212	3.596	3.978	4.358	4.737		18
11				1.380	1.724	2.068	2.412	2.755	3.099	3.443	3.780	4.130		20
12				1.170	1.474	1.779	2.087	2.396	2.706	3.017	3.330	3.643		23
13				1.005	1.275	1.549	1.826	2.106	2.388	2.673	2.959	3.247	3.536	23
14				0.873	1.116	1.363	1.615	1.870	2.128	2.389	2.652	2.918	3.186	10
15					0.985	1.210	1.439	1.673	1.911	2.152	2.396	2.642	2.892	7
16					0.877	1.082	1.293	1.508	1.728	1.951	2.178	2.408	2.641	4
17							1.169	1.368	1.572	1.780	1.992	2.207	2.425	3
18							1.063	1.248	1.438	1.632	1.830	2.032	2.238	1
19							0.971	1.144	1.322	1.504	1.690	1.880	2.074	1
20								1.053	1.220	1.391	1.567	1.746	1.930	2
21								0.974	1.131	1.292	1.458	1.628	1.802	1
22								0.904	1.052	1.204	1.361	1.522	1.688	0
23								0.841	0.981	1.126	1.275	1.428	1.585	0
24								0.786	0.918	1.055	1.197	1.343	1.493	0

Log V = 2.11511 -3.43175 (log D) +0.958133 (log D) (log H)
S.D. of coeff. 0.256364 0.104981
S.E. = 0.06269

Mean Error = 14.1 percent
Ave. Bias = -1.21 percent
Ave. Deviation = 11.0 percent

Table 27.--*Top cubic volume, inside bark (7-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	Cubic feet													*No. trees*
8			3.525	4.586	5.625	6.646	7.652	8.647	9.631	10.605				2
9				3.602	4.470	5.331	6.188	7.040	7.890	8.736	9.579			18
10				2.903	3.639	4.377	5.117	5.858	6.601	7.344	8.089	8.834		18
11				2.387	3.021	3.662	4.309	4.961	5.617	6.278	6.942	7.609		20
12				1.997	2.549	3.112	3.683	4.262	4.848	5.440	6.037	6.640		23
13				1.695	2.181	2.679	3.188	3.706	4.233	4.768	5.309	5.857	6.411	23
14				1.456	1.887	2.332	2.789	3.257	3.734	4.220	4.714	5.215	5.723	10
15					1.649	2.050	2.463	2.888	3.323	3.767	4.220	4.681	5.150	7
16					1.454	1.816	2.192	2.580	2.979	3.387	3.805	4.231	4.665	4
17							1.965	2.321	2.688	3.065	3.452	3.848	4.252	3
18							1.773	2.101	2.440	2.790	3.150	3.518	3.895	1
19							1.608	1.912	2.227	2.552	2.888	3.233	3.586	1
20								1.748	2.042	2.346	2.660	2.983	3.315	2
21								1.605	1.880	2.165	2.459	2.764	3.076	1
22								1.480	1.737	2.005	2.283	2.569	2.865	0
23								1.370	1.611	1.864	2.125	2.396	2.676	0
24								1.272	1.499	1.737	1.985	2.242	2.507	0

Log V = 2.51253 -3.67288 (log D) +1.01315 (log D) (log H)
S.D. of coeff. 0.26597 0.108819
S.E. = 0.06256

Mean Error = 14.2 percent
Ave. Bias = -1.14 percent
Ave. Deviation = 11.2 percent

Table 28.--*Top cubic volume, inside bark (8-inch top diameter)--western larch*

D.b.h. (inches)	Total height (feet)													Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	130	
	Cubic feet													*No. trees*
9				5.854	7.429	9.026	10.641	12.272	13.917	15.574	17.243			6
10				4.628	5.940	7.285	8.657	10.052	11.468	12.904	14.356	15.824		14
11				3.741	4.853	6.001	7.182	8.392	9.627	10.884	12.163	13.461		20
12				3.081	4.034	5.028	6.057	7.117	8.205	9.318	10.455	11.614		23
13				2.577	3.404	4.273	5.178	6.116	7.083	8.077	9.096	10.139	11.203	23
14				2.185	2.909	3.675	4.478	5.315	6.182	7.076	7.996	8.941	9.907	10
15					2.512	3.194	3.912	4.664	5.446	6.256	7.092	7.953	8.836	7
16					2.191	2.801	3.448	4.127	4.837	5.575	6.339	7.128	7.940	4
17							3.062	3.680	4.328	5.003	5.705	6.431	7.181	3
18							2.737	3.302	3.896	4.518	5.165	5.837	6.531	1
19							2.462	2.981	3.528	4.102	4.702	5.325	5.971	1
20								2.705	3.211	3.743	4.300	4.881	5.485	2
21								2.466	2.936	3.431	3.951	4.493	5.058	1
22								2.258	2.695	3.157	3.643	4.152	4.683	0
23								2.076	2.484	2.917	3.372	3.851	4.350	0
24								1.915	2.297	2.703	3.132	3.582	4.054	0

Log V = 2.89616 -4.02373 (log D) +1.11914 (log D) (log H)
S.D. of coeff. 0.302677 0.120186
S.E. = 0.06567

Mean Error = 15.1 percent
Ave. Bias = -1.14 percent
Ave. Deviation = 11.4 percent

Table 29.--*Gross cubic bark volume, entire stem--western larch*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	130	Sample size
	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	*Cubic feet*	- - - -	- - - -	- - - -	- - - -	- - - -	- - - -	*No. trees*
2	0.02	0.04	0.07	0.09	0.11	0.13								17
3	0.05	0.10	0.15	0.20	0.25	0.30								20
4	0.09	0.17	0.26	0.35	0.44	0.53	0.62							18
5		0.27	0.41	0.55	0.69	0.83	0.98	1.12						16
6		0.39	0.60	0.80	1.00	1.20	1.41	1.61						17
7			0.81	1.09	1.36	1.64	1.92	2.20	2.47	2.75				16
8			1.06	1.42	1.78	2.14	2.51	2.87	3.24	3.60				14
9				1.80	2.26	2.72	3.18	3.64	4.10	4.56	5.03			18
10				2.22	2.79	3.36	3.92	4.49	5.07	5.64	6.21	6.78		18
11				2.69	3.38	4.06	4.75	5.44	6.13	6.83	7.52	8.21		20
12				3.21	4.02	4.84	5.66	6.48	7.31	8.13	8.96	9.78		23
13				3.77	4.72	5.69	6.65	7.61	8.58	9.55	10.52	11.49	12.46	23
14				4.37	5.48	6.60	7.72	8.84	9.96	11.08	12.21	13.33	14.46	10
15					6.30	7.58	8.86	10.15	11.44	12.73	14.02	15.32	16.61	7
16						8.63	10.09	11.55	13.02	14.49	15.96	17.44	18.91	4
17						9.75	11.40	13.05	14.71	16.37	18.03	19.69	21.36	3
18						10.93	12.78	14.64	16.50	18.36	20.22	22.09	23.96	1
19							14.25	16.32	18.39	20.46	22.54	24.62	26.71	1
20							15.79	18.09	20.38	22.68	24.99	27.30	29.61	2
21							17.42	19.95	22.48	25.02	27.56	30.11	32.65	1
22							19.13	21.90	24.69	27.47	30.26	33.06	35.85	0
23							20.91	23.95	26.99	30.04	33.09	36.14	39.20	0
24							22.78	26.09	29.40	32.72	36.04	39.37	42.70	0

Log V = -3.28754 +2.00871 (log D) +1.0194 (log H)
S.D. of coeff. 0.043917 0.062718
S.E. = 0.05552

Mean error = 13.0 percent
Ave. bias = -0.06 percent
Ave. deviation = 10.0 percent

Table 30.--*Double bark thickness for stem sections of specified diameter--western larch*

D.o.b. (inches)	D.o.b. (10ths of inches)										D.o.b. (inches)
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
	Inches										
2	0.16	0.17	0.18	0.19	0.21	0.22	0.23	0.24	0.26	0.27	2
3	0.28	0.29	0.31	0.32	0.33	0.35	0.36	0.37	0.38	0.40	3
4	0.41	0.42	0.43	0.45	0.46	0.47	0.48	0.50	0.51	0.52	4
5	0.53	0.55	0.56	0.57	0.58	0.60	0.61	0.62	0.63	0.65	5
6	0.66	0.67	0.68	0.70	0.71	0.72	0.73	0.75	0.76	0.77	6
7	0.79	0.80	0.81	0.82	0.84	0.85	0.86	0.87	0.89	0.90	7
8	0.91	0.92	0.94	0.95	0.96	0.97	0.99	1.00	1.01	1.02	8
9	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.14	1.15	9
10	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.25	1.26	1.28	10
11	1.29	1.30	1.31	1.33	1.34	1.35	1.36	1.38	1.39	1.40	11
12	1.41	1.43	1.44	1.45	1.46	1.48	1.49	1.50	1.51	1.53	12
13	1.54	1.55	1.56	1.58	1.59	1.60	1.61	1.63	1.64	1.65	13
14	1.67	1.68	1.69	1.70	1.72	1.73	1.74	1.75	1.77	1.78	14
15	1.79	1.80	1.82	1.83	1.84	1.85	1.87	1.88	1.89	1.90	15
16	1.92	1.93	1.94	1.95	1.97	1.98	1.99	2.00	2.02	2.03	16
17	2.04	2.05	2.07	2.08	2.09	2.11	2.12	2.13	2.14	2.16	17
18	2.17	2.18	2.19	2.21	2.22	2.23	2.24	2.26	2.27	2.28	18
19	2.29	2.31	2.32	2.33	2.34	2.36	2.37	2.38	2.39	2.41	19
20	2.42	2.43	2.44	2.46	2.47	2.48	2.49	2.51	2.52	2.53	20

Values computed from the single-bark-thickness equation:

$T = -0.0474573 + 0.0628597$ (D.o.b.)
S.D. of coeff. 0.00056604
S.E. = 0.068016
$R^2 = 0.905$
N = 1,295

Table 31.--*Total cubic volume, inside bark, including stump and top--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
2	0.19	0.25	0.33	0.43	0.57	0.76							27
3	0.44	0.56	0.72	0.93	1.20	1.55							32
4	0.79	1.00	1.27	1.61	2.04	2.59	3.29						22
5		1.56	1.96	2.45	3.07	3.85	4.82						26
6		2.25	2.79	3.46	4.30	5.33	6.60	8.18	10.15				16
7		3.07	3.77	4.64	5.70	7.00	8.61	10.58	13.00				24
8		4.01	4.89	5.97	7.28	8.88	10.83	13.22	16.12				15
9		5.08	6.15	7.46	9.04	10.95	13.27	16.08	19.48				19
10			7.56	9.10	10.96	13.21	15.91	19.16	23.08				12
11			9.10	10.90	13.06	15.65	18.74	22.46	26.91	32.24			18
12			10.78	12.85	15.32	18.26	21.77	25.96	30.95	36.90	44.00		26
13			12.59	14.95	17.74	21.06	24.99	29.66	35.21	41.79	49.59		18
14				17.19	20.32	24.02	28.39	33.56	39.66	46.88	55.41		13
15				19.59	23.07	27.16	31.97	37.64	44.32	52.18	61.43		15
16				22.13	25.96	30.46	35.73	41.91	49.17	57.68	67.66		18
17				24.82	29.02	33.92	39.66	46.37	54.21	63.37	74.09		21
18				27.65	32.23	37.55	43.76	51.00	59.43	69.25	80.70		13
19					35.59	41.34	48.03	55.80	64.83	75.32	87.50	101.66	11
20						45.29	52.47	60.78	70.41	81.56	94.48	109.45	8
21						49.39	57.06	65.92	76.15	87.98	101.63	117.41	3
22						53.65	61.82	71.23	82.07	94.57	108.96	125.54	4
23						58.07	66.74	76.70	88.16	101.32	116.45	133.84	0
24						62.63	71.81	82.34	94.40	108.24	124.11	142.30	0
25							77.04	88.13	100.81	115.32	131.92	150.91	1
26							82.42	94.08	107.38	122.56	139.90	159.68	1

Log V =	-1.48037	+2.11615 (log D)	+0.0137202 (H)	-0.00563672 (log D)(H)
S.D. of coeff.		0.0262754	0.00056526	0.000420829

S.E. = 0.04546

Mean error = 11.1 percent
Ave. bias = -0.85 percent
Ave. deviation = 7.9 percent

Table 32.--*Top cubic volume, inside bark (2-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
3	0.074	0.091	0.103	0.113	0.121	0.128							30
4	0.053	0.069	0.081	0.090	0.098	0.105	0.112						22
5		0.056	0.067	0.076	0.084	0.091	0.097						26
6		0.047	0.057	0.066	0.073	0.080	0.087	0.092	0.098				16
7		0.040	0.050	0.058	0.066	0.072	0.079	0.084	0.090				24
8		0.035	0.044	0.052	0.060	0.066	0.072	0.078	0.083				15
9		0.031	0.040	0.048	0.055	0.061	0.067	0.073	0.078				19
10			0.037	0.044	0.051	0.057	0.063	0.068	0.074				12
11			0.034	0.041	0.047	0.053	0.059	0.065	0.070				18
12			0.031	0.038	0.044	0.050	0.056	0.061	0.067	0.071			26
13			0.029	0.036	0.042	0.048	0.053	0.059	0.064	0.069	0.073		18
14				0.034	0.040	0.045	0.051	0.056	0.061	0.066	0.071		13
15				0.032	0.038	0.043	0.049	0.054	0.059	0.064	0.068		15
16				0.031	0.036	0.042	0.047	0.052	0.057	0.061	0.066		18
17				0.029	0.035	0.040	0.045	0.050	0.055	0.059	0.064		21
18				0.028	0.033	0.038	0.043	0.048	0.053	0.058	0.062		13
19					0.032	0.037	0.042	0.047	0.051	0.056	0.061	0.065	11
20					0.031	0.036	0.041	0.045	0.050	0.055	0.059	0.063	8
21						0.035	0.039	0.044	0.049	0.053	0.058	0.062	3
22						0.034	0.038	0.043	0.047	0.052	0.056	0.061	4
23						0.033	0.037	0.042	0.046	0.051	0.055	0.059	0
24						0.032	0.036	0.041	0.045	0.050	0.054	0.058	0
25							0.035	0.040	0.044	0.048	0.053	0.057	1
26							0.034	0.039	0.043	0.047	0.052	0.056	1

Log V = -0.57482 -1.79704 (log D) +0.63400 (log D) (log H)
S.D. of coeff. 0.14463 -0.064633
S.E. = 0.07169

Mean error = 16.4 percent
Ave. bias = -1.5 percent
Ave. deviation = 12.6 percent

Table 33.--*Top cubic volume, inside bark (3-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
4	0.228	0.303	0.359	0.404	0.444	0.478	0.510						18
5		0.230	0.280	0.321	0.358	0.390	0.420						26
6		0.184	0.228	0.266	0.300	0.331	0.359	0.386	0.411				16
7		0.152	0.192	0.227	0.258	0.287	0.314	0.340	0.364				24
8		0.128	0.165	0.198	0.227	0.254	0.280	0.304	0.327				15
9		0.111	0.145	0.175	0.203	0.228	0.253	0.276	0.298				19
10			0.129	0.157	0.183	0.208	0.231	0.253	0.274				12
11			0.116	0.142	0.167	0.190	0.213	0.234	0.254				18
12			0.105	0.130	0.154	0.176	0.197	0.218	0.238	0.257	0.276		26
13			0.096	0.120	0.142	0.163	0.184	0.204	0.223	0.242	0.260		18
14				0.111	0.132	0.153	0.173	0.192	0.210	0.229	0.246		13
15				0.103	0.124	0.143	0.163	0.181	0.199	0.217	0.234		15
16				0.097	0.116	0.135	0.154	0.172	0.189	0.207	0.224		18
17				0.091	0.110	0.128	0.146	0.163	0.180	0.197	0.214		21
18				0.086	0.104	0.121	0.139	0.156	0.172	0.189	0.205		13
19					0.098	0.116	0.132	0.149	0.165	0.181	0.197	0.213	11
20					0.094	0.110	0.127	0.143	0.159	0.174	0.190	0.205	8
21						0.106	0.121	0.137	0.153	0.168	0.183	0.198	3
22						0.101	0.117	0.132	0.147	0.162	0.177	0.192	4
23						0.097	0.112	0.127	0.142	0.157	0.172	0.186	0
24						0.093	0.108	0.123	0.137	0.152	0.166	0.181	0
25							0.104	0.119	0.133	0.147	0.161	0.176	1
26							0.101	0.115	0.129	0.143	0.157	0.171	1

Log V = 0.22840 -2.13544 (log D) +0.68846 (log D) (log H)
S.D. of coeff. 0.14572 0.063693
S.E. = 0.06622

Mean error = 15.6 percent
Ave. bias = -1.6 percent
Ave. deviation = 11.8 percent

Table 34.--*Top cubic volume, inside bark (4-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
5		0.682	0.820	0.934	1.033	1.122	1.203						17
6		0.534	0.654	0.757	0.846	0.928	1.003	1.073	1.138				16
7		0.433	0.541	0.633	0.715	0.791	0.860	0.925	0.987				24
8		0.362	0.459	0.543	0.618	0.688	0.753	0.814	0.872				15
9		0.309	0.397	0.474	0.544	0.609	0.670	0.727	0.782				19
10			0.348	0.420	0.485	0.546	0.603	0.657	0.709				12
11			0.310	0.376	0.437	0.494	0.548	0.600	0.649				18
12			0.278	0.340	0.397	0.451	0.503	0.552	0.599	0.645	0.689		26
13			0.252	0.310	0.364	0.415	0.464	0.511	0.556	0.600	0.643		18
14				0.285	0.336	0.384	0.431	0.476	0.519	0.562	0.603		13
15				0.263	0.311	0.358	0.402	0.445	0.487	0.528	0.568		15
16				0.244	0.290	0.335	0.377	0.419	0.459	0.498	0.537		18
17				0.227	0.272	0.314	0.355	0.395	0.434	0.472	0.509		21
18				0.213	0.255	0.296	0.336	0.374	0.412	0.448	0.484		13
19					0.241	0.280	0.318	0.355	0.391	0.427	0.462	0.497	11
20					0.228	0.265	0.302	0.338	0.373	0.408	0.442	0.476	8
21						0.252	0.288	0.323	0.357	0.391	0.424	0.456	3
22						0.240	0.275	0.309	0.342	0.375	0.407	0.439	4
23						0.229	0.263	0.296	0.328	0.360	0.391	0.423	0
24						0.219	0.252	0.284	0.315	0.346	0.377	0.408	0
25							0.242	0.273	0.304	0.334	0.364	0.394	1
26							0.233	0.263	0.293	0.322	0.352	0.381	1

Log V = 0.77690 -2.19153 (log D) +0.64755 (log D) (log H)
S.D. of coeff. 0.141294 0.0606155
S.E. = 0.06072

Mean error = 14.3 percent
Ave. bias = -1.3 percent
Ave. deviation = 11.3 percent

Table 35'.--*Top cubic volume, inside bark (5-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
6		1.264	1.558	1.806	2.206	2.225	2.409	2.580	2.742				8
7		1.001	1.256	1.475	1.671	1.850	2.016	2.173	2.321				24
8		0.818	1.042	1.237	1.414	1.576	1.729	1.872	2.009				15
9		0.684	0.884	1.060	1.220	1.369	1.509	1.642	1.768				19
10			0.763	0.923	1.070	1.207	1.336	1.460	1.578				12
11			0.668	0.814	0.949	1.076	1.197	1.312	1.423				18
12			0.591	0.726	0.852	0.970	1.083	1.191	1.295	1.397			26
13			0.529	0.654	0.770	0.881	0.987	1.089	1.188	1.284	1.377		18
14				0.593	0.702	0.806	0.906	1.003	1.096	1.188	1.277		13
15				0.542	0.644	0.742	0.837	0.929	1.018	1.105	1.190		15
16				0.497	0.594	0.687	0.777	0.864	0.949	1.032	1.113		18
17				0.459	0.551	0.639	0.724	0.808	0.889	0.968	1.046		21
18				0.426	0.513	0.597	0.678	0.758	0.836	0.912	0.987		13
19					0.479	0.559	0.637	0.713	0.788	0.861	0.934	1.005	11
20					0.450	0.526	0.601	0.674	0.746	0.816	0.886	0.955	8
21						0.496	0.568	0.638	0.707	0.775	0.843	0.910	3
22						0.469	0.538	0.606	0.672	0.738	0.804	0.868	4
23						0.445	0.511	0.576	0.641	0.705	0.768	0.830	0
24						0.423	0.487	0.550	0.612	0.674	0.735	0.796	0
25							0.464	0.525	0.586	0.646	0.705	0.764	1
26							0.444	0.503	0.561	0.619	0.677	0.735	1

Log V = 1.27970 -2.37428 (log D) +0.66145 (log D) (log H)
S.D. of coeff. 0.156891 0.0669301
S.E. = 0.06570

Mean error = 15.6 percent
Ave. bias = -1.6 percent
Ave. deviation = 11.9 percent

Table 36.--*Top cubic volume, inside bark (6-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
7			2.447	2.904	3.317	3.698	4.054	4.389	4.709				7
8			1.992	2.392	2.758	3.097	3.417	3.720	4.010				15
9			1.662	2.016	2.343	2.649	2.938	3.214	3.480				19
10			1.413	1.730	2.025	2.303	2.567	2.821	3.065				12
11			1.220	1.507	1.775	2.029	2.272	2.506	2.733				18
12			1.067	1.328	1.574	1.808	2.033	2.250	2.461	2.667			26
13			0.943	1.182	1.409	1.626	1.835	2.038	2.235	2.428	2.617		18
14				1.062	1.271	1.473	1.660	1.859	2.044	2.226	2.404		13
15				0.960	1.156	1.344	1.528	1.706	1.881	2.053	2.222		15
16				0.875	1.057	1.234	1.406	1.575	1.741	1.904	2.064		18
17				0.801	0.972	1.138	1.301	1.461	1.618	1.773	1.926		21
18				0.737	0.898	1.055	1.209	1.361	1.511	1.658	1.804		13
19					0.833	0.982	1.129	1.273	1.416	1.557	1.696	1.835	11
20					0.776	0.917	1.057	1.195	1.331	1.466	1.600	1.733	8
21						0.860	0.993	1.124	1.255	1.384	1.513	1.641	3
22						0.808	0.935	1.061	1.187	1.311	1.435	1.558	4
23						0.762	0.884	1.004	1.125	1.244	1.364	1.483	0
24						0.720	0.837	0.953	1.069	1.184	1.299	1.414	0
25							0.794	0.906	1.017	1.129	1.240	1.351	1
26							0.755	0.863	0.970	1.078	1.186	1.293	1

Log V = 1.69009 -2.58148 (log D) +0.70505 (log D) (log H)
S.D. of coeff. 0.180394 0.0762105
S.E. = 0.07278

Mean error = 17.2 percent
Ave. bias = -1.9 percent
Ave. deviation = 13.4 percent

Table 37.--*Top cubic volume, inside bark (7-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	Cubic feet												*No. trees*
8			3.534	4.253	4.910	5.522	6.098	6.645	7.169				1
9			2.916	3.547	4.128	4.673	5.190	5.683	6.157				16
10			2.456	3.015	3.535	4.025	4.493	4.941	5.374				12
11			2.102	2.603	3.071	3.517	3.943	4.354	4.752				18
12			1.824	2.276	2.702	3.109	3.500	3.879	4.247	4.605			26
13			1.600	2.011	2.401	2.775	3.137	3.488	3.830	4.164	4.491		18
14				1.794	2.153	2.499	2.834	3.161	3.480	3.793	4.100		13
15				1.613	1.945	2.266	2.579	2.884	3.183	3.477	3.767		15
16				1.460	1.768	2.068	2.361	2.647	2.929	3.206	3.479		18
17				1.330	1.617	1.898	2.173	2.443	2.708	2.971	3.230		21
18				1.218	1.487	1.750	2.009	2.264	2.516	2.764	3.010		13
19					1.373	1.621	1.866	2.107	2.346	2.582	2.817	3.049	11
20					1.273	1.507	1.739	1.968	2.196	2.421	2.645	2.867	8
21					1.185	1.407	1.627	1.845	2.062	2.277	2.491	2.704	3
22						1.317	1.526	1.734	1.941	2.147	2.352	2.557	4
23						1.237	1.436	1.635	1.883	2.030	2.227	2.424	0
24						1.164	1.355	1.545	1.735	1.925	2.114	2.303	0
25							1.281	1.464	1.646	1.828	2.010	2.192	1
26							1.214	1.389	1.565	1.740	1.916	2.091	1

Log V = 2.02163 -2.68436 (log D) +0.71282 (log D) (log H)
S.D. of coeff. 0.180002 0.074193
S.E. = 0.06808

Mean error = 16.3 percent
Ave. bias = -1.6 percent
Ave. deviation = 12.4 percent

Table 38.--*Top cubic volume, inside bark (8-inch top diameter)--Douglas-fir*

D.b.h. (inches)	Total height (feet)												Sample size
	10	20	30	40	50	60	70	80	90	100	110	120	
	Cubic feet												*No. trees*
9			4.701	5.896	7.029	8.115	9.162	10.178	11.167				3
10			3.862	4.897	5.887	6.843	7.772	8.677	9.563				11
11			3.233	4.140	5.015	5.865	6.696	7.511	8.311				18
12			2.748	3.551	4.332	5.095	5.845	6.583	7.312	8.031			26
13			2.367	3.084	3.786	4.477	5.158	5.832	6.499	7.160	7.815		18
14				2.706	3.342	3.971	4.594	5.213	5.827	6.438	7.045		13
15				2.396	2.975	3.552	4.125	4.696	5.264	5.831	6.396		15
16				2.138	2.669	3.199	3.729	4.258	4.787	5.316	5.844		18
17				1.922	2.410	2.901	3.392	3.885	4.378	4.873	5.368		21
18				1.737	2.189	2.644	3.102	3.563	4.025	4.489	4.955		13
19					1.999	2.423	2.851	3.283	3.717	4.154	4.594	5.036	11
20					1.834	2.230	2.632	3.037	3.447	3.860	4.275	4.694	8
21					1.689	2.061	2.438	2.821	3.208	3.599	3.993	4.391	3
22						1.911	2.267	2.629	2.995	3.366	3.741	4.120	4
23						1.779	2.115	2.458	2.806	3.158	3.515	3.877	0
24						1.661	1.979	2.304	2.635	2.971	3.312	3.657	0
25							1.857	2.166	2.482	2.802	3.128	3.458	1
26							1.747	2.041	2.342	2.649	2.961	3.278	1

Log V = 2.45281 -3.08509 (log D) +0.82531 (log D) (log H)
S.D. of coeff. 0.179249 0.0728263
S.E. = 0.06559

Mean error = 15.5 percent
Ave. bias = -1.4 percent
Ave. deviation = 12.0 percent

Table 39.--*Gross cubic bark volume, entire stem--Douglas-fir*

D.b.h. (inches)	Total height (feet) 10	20	30	40	50	60	70	80	90	100	110	120	Sample size
	Cubic feet												*No. trees*
2	0.03	0.05	0.07	0.09	0.11	0.13							27
3	0.05	0.10	0.14	0.19	0.23	0.27							32
4	0.08	0.16	0.24	0.32	0.39	0.46	0.54						22
5		0.24	0.36	0.47	0.59	0.70	0.82						26
6		0.33	0.49	0.66	0.82	0.99	1.15	1.32	1.48				16
7		0.43	0.65	0.87	1.10	1.32	1.55	1.77	2.00				24
8		0.54	0.83	1.11	1.40	1.70	1.99	2.29	2.58				15
9		0.67	1.02	1.38	1.75	2.12	2.49	2.86	3.24				19
10			1.23	1.67	2.12	2.58	3.04	3.50	3.97				12
11			1.46	1.99	2.53	3.08	3.63	4.20	4.76	5.33			18
12			1.71	2.33	2.97	3.62	4.29	4.95	5.63	6.31	7.00		26
13			1.97	2.70	3.45	4.21	4.99	5.77	6.57	7.37	8.18		18
14				3.09	3.95	4.84	5.74	6.65	7.57	8.51	9.45		13
15				3.50	4.49	5.50	6.54	7.58	8.65	9.72	10.81		15
16				3.94	5.06	6.21	7.38	8.58	9.79	11.02	12.26		18
17				4.40	5.66	6.96	8.28	9.63	11.00	12.39	13.80		21
18				4.88	6.29	7.74	9.23	10.74	12.28	13.84	15.42		13
19					6.96	8.57	10.22	11.91	13.62	15.37	17.14	18.93	11
20						9.43	11.26	13.13	15.03	16.97	18.94	20.93	8
21						10.33	12.35	14.41	16.51	18.65	20.82	23.03	3
22						11.27	13.49	15.75	18.06	20.41	22.80	25.22	4
23						12.25	14.67	17.14	19.67	22.24	24.86	27.52	0
24						13.27	15.90	18.59	21.35	24.15	27.01	29.91	0
25							17.17	20.10	23.09	26.14	29.24	32.40	1
26							18.50	21.66	24.90	28.20	31.56	34.98	1

Log V = -2.84449	+1.36408 (log D)	+0.777852 (log H)	+0.285834 (log D) (log H)
S.D. of coeff.	0.119975	0.056642	0.061730

S.E. = 0.06428

Mean error = 14.6 percent
Ave. bias = -0.12 percent
Ave. deviation = 10.8 percent

Table 40.--*Double bark thickness for stem sections of specified diameter--Douglas-fir*

D.o.b. (inches)	D.o.b. (10ths of inches) 0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	D.o.b. (inches)
					Inches						
2	0.13	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.20	0.21	2
3	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.30	3
4	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.40	4
5	0.41	0.42	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	5
6	0.50	0.51	0.52	0.53	0.54	0.54	0.55	0.56	0.57	0.58	6
7	0.59	0.60	0.61	0.62	0.63	0.64	0.65	0.66	0.66	0.67	7
8	0.68	0.69	0.73	0.71	0.72	0.73	0.74	0.75	0.76	0.77	8
9	0.78	0.78	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.86	9
10	0.87	0.88	0.89	0.89	0.90	0.91	0.92	0.93	0.94	0.95	10
11	0.96	0.97	0.98	0.99	1.00	1.01	1.01	1.02	1.03	1.04	11
12	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.13	12
13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23	13
14	1.24	1.25	1.25	1.26	1.27	1.28	1.29	1.30	1.31	1.32	14
15	1.33	1.34	1.35	1.36	1.37	1.37	1.38	1.39	1.40	1.41	15
16	1.42	1.43	1.44	1.45	1.46	1.47	1.48	1.49	1.49	1.50	16
17	1.51	1.52	1.53	1.54	1.55	1.56	1.57	1.58	1.59	1.60	17
18	1.61	1.61	1.62	1.63	1.64	1.65	1.66	1.67	1.68	1.69	18
19	1.70	1.71	1.72	1.73	1.73	1.74	1.75	1.76	1.77	1.78	19
20	1.79	1.80	1.81	1.82	1.83	1.84	1.85	1.85	1.86	1.87	20

Values computed from the single-bark-thickness equation:

T = -0.0276673 +0.0461299 (D.o.b.)
S.D. of coeff. 0.000372306
S.E. = 0.0659404
R^2 = 0.895
N = 1,815

Table 41.--*Relationship between stump diameter and diameter at breast height (inches)*

Stump diameter range, i.b.				D.b.h. class o.b.
Ponderosa pine	Douglas-fir	Western larch	Lodgepole pine	
1.7-2.6	1.7-2.6	1.7-2.6	1.4-2.4	2
2.7-3.6	2.7-3.7	2.7-3.5	2.5-3.6	3
3.7-4.6	3.8-4.7	3.6-4.5	3.7-4.7	4
4.7-5.5	4.8-5.7	4.6-5.5	4.8-5.8	5
5.6-6.5	5.8-6.8	5.6-6.4	6.0-7.0	6
6.6-7.5	6.9-7.8	6.5-7.4	7.1-8.1	7
7.6-8.5	7.9-8.8	7.5-8.3	8.3-9.3	8
8.6-9.5	8.9-9.9	8.4-9.3	9.4-10.4	9
9.6-10.5	10.0-10.9	9.4-10.3	10.5-11.6	10
10.6-11.5	11.0-11.9	10.4-11.2	11.7-12.7	11
11.6-12.5	12.0-13.0	11.3-12.2	12.8-13.9	12
12.6-13.5	13.1-14.0	12.3-13.2	14.0-15.0	13
13.6-14.5	14.1-15.0	13.3-14.0	15.1-16.1	14
14.6-15.5	15.2-16.1	14.2-15.1	16.3-17.3	15
15.6-16.5	16.2-17.1	15.2-16.1	17.4-18.4	16
16.6-17.5	17.2-18.2	16.2-17.0	18.6-19.6	17
17.6-18.5	18.3-19.2	17.1-18.0	19.7-20.7	18
18.6-19.4	19.3-20.2	18.1-19.0	20.8-21.9	19
19.5-20.4	20.3-21.3	19.1-19.9	22.0-23.0	20
20.5-21.4	21.4-22.3	20.0-20.9	23.1-24.2	21
21.5-22.4	22.4-23.3	21.0-21.9	24.3-25.3	22
22.5-23.4	23.4-24.4	22.0-22.8	25.4-26.5	23
23.5-24.4	24.5-25.4	22.9-23.8	26.6-27.6	24

Regression Equations

Species	Equation	S.D. of the Coefficient	S.E.	R^2
Ponderosa pine	$D = -0.186432 + 1.00729\ S$	0.0060791	0.65264	0.987
Douglas-fir	$D = -0.126425 + 0.965427\ S$	0.0062658	0.69986	0.985
Western larch	$D = -0.253227 + 1.03641\ S$	0.0063114	0.41618	0.991
Lodgepole pine	$D = -0.292117 + 0.873569\ S$	0.0078078	0.54636	0.982

D = d.b.h.
S = Stump diameter, inside bark

Table 42.--*Stand volume, cubic feet per acre--ponderosa pine*

Basal area (ft^2)	Average height of dominant trees (feet)											
	20	30	40	50	60	70	80	90	100	110	120	130
20	144	216	288	360	432	504	576	648	720	792	864	936
40	288	432	576	720	864	1,008	1,152	1,296	1,440	1,584	1,728	1,872
60	432	648	864	1,080	1,296	1,512	1,728	1,943	2,160	2,376	2,592	2,808
80	576	864	1,152	1,440	1,728	2,016	2,304	2,592	2,880	3,168	3,456	3,744
100	720	1,080	1,440	1,800	2,160	2,520	2,880	3,240	3,600	3,960	4,320	4,680
120	864	1,296	1,728	2,160	2,592	3,024	3,456	3,887	4,320	4,752	5,184	5,616
140	1,008	1,512	2,016	2,520	3,024	3,528	4,032	4,536	5,040	5,544	6,048	6,552
160	1,152	1,728	2,304	2,880	3,456	4,032	4,608	5,184	5,760	6,336	6,912	7,488
180	1,296	1,944	2,592	3,240	3,888	4,536	5,184	5,832	6,480	7,128	7,776	8,424
200	1,440	2,160	2,880	3,600	4,320	5,040	5,760	6,480	7,200	7,920	8,640	9,360
220	1,584	2,376	3,168	3,960	4,752	5,544	6,336	7,128	7,920	8,712	9,504	10,296
240	1,728	2,592	3,456	4,320	5,184	6,048	6,912	7,775	8,640	9,504	10,368	11,232
260	1,871	2,807	3,743	4,680	5,615	6,551	7,487	8,424	9,360	10,295	11,231	12,167
280	2,016	3,024	4,032	5,040	6,048	7,056	8,064	9,072	10,080	11,088	12,096	13,104
300	2,160	3,240	4,320	5,400	6,480	7,560	8,640	9,720	10,800	11,880	12,960	14,040

Table 43.--*Stand volume, cubic feet per acre--lodgepole pine*

Basal area (ft^2)	Average height of dominant trees (feet)								
	20	30	40	50	60	70	80	90	100
20	184	286	368	460	552	644	736	828	920
40	368	552	736	920	1,104	1,288	1,472	1,656	1,840
60	552	828	1,104	1,380	1,656	1,932	2,208	2,484	2,760
80	736	1,104	1,472	1,840	2,208	2,576	2,944	3,312	3,680
100	920	1,380	1,840	2,300	2,760	3,220	3,680	4,140	4,600
120	1,104	1,656	2,208	2,760	3,312	3,864	4,416	4,968	5,520
140	1,288	1,932	2,576	3,220	3,864	4,508	5,152	5,796	6,440
160	1,472	2,208	2,944	3,680	4,416	5,152	5,888	6,624	7,360
180	1,656	2,484	3,312	4,140	4,968	5,796	6,624	7,452	8,280
200	1,840	2,760	3,680	4,600	5,520	6,440	7,360	8,280	9,200
220	2,024	3,036	4,048	5,060	6,072	7,084	8,096	9,108	10,120
240	2,208	3,312	4,416	5,520	6,624	7,728	8,832	9,936	11,040
260	2,392	3,588	4,784	5,980	7,176	8,372	9,568	10,764	11,960
280	2,576	3,864	5,152	6,440	7,728	9,016	10,304	11,592	12,880
300	2,760	4,140	5,520	6,900	8,280	9,660	11,040	12,420	13,800

Table 44.--*Stand volume, cubic feet per acre--western larch*

Basal area (ft^2)	Average height of dominant trees (feet)											
	20	30	40	50	60	70	80	90	100	110	120	130
20	144	216	288	360	432	504	576	648	720	792	864	936
40	288	432	576	720	864	1,008	1,152	1,296	1,440	1,584	1,728	1,872
60	432	648	864	1,080	1,296	1,512	1,728	1,943	2,160	2,376	2,592	2,808
80	576	864	1,152	1,440	1,728	2,016	2,304	2,592	2,880	3,168	3,456	3,744
100	720	1,080	1,440	1,800	2,160	2,520	2,880	3,240	3,600	3,960	4,320	4,680
120	864	1,296	1,728	2,160	2,592	3,024	3,456	3,887	4,320	4,752	5,184	5,616
140	1,008	1,512	2,016	2,520	3,024	3,528	4,032	4,536	5,040	5,544	6,048	6,552
160	1,152	1,728	2,304	2,880	3,456	4,032	4,608	5,184	5,760	6,336	6,912	7,488
180	1,296	1,944	2,592	3,240	3,888	4,536	5,184	5,832	6,480	7,128	7,776	8,424
200	1,440	2,160	2,880	3,600	4,320	5,040	5,760	6,480	7,200	7,920	8,640	9,360
220	1,584	2,376	3,168	3,960	4,752	5,544	6,336	7,128	7,920	8,712	9,504	10,296
240	1,728	2,592	3,456	4,320	5,184	6,048	6,912	7,775	8,640	9,504	10,368	11,232
260	1,871	2,807	3,743	4,680	5,615	6,551	7,487	8,424	9,360	10,295	11,231	12,167
280	2,016	3,024	4,032	5,040	6,048	7,056	8,064	9,072	10,080	11,088	12,096	13,104
300	2,160	3,240	4,320	5,400	6,480	7,560	8,640	9,720	10,800	11,880	12,960	14,040

Table 45.--*Stand volume, cubic feet per acre--Douglas-fir*

Basal area (ft^2)	Average height of dominant trees (feet)											
	20	30	40	50	60	70	80	90	100	110	120	130
20	160	240	320	400	480	560	648	720	800	880	960	1,040
40	320	480	640	800	960	1,120	1,440	1,600	1,600	1,760	1,920	2,080
60	480	720	960	1,200	1,440	1,680	1,920	2,160	2,400	2,640	2,880	3,120
80	640	960	1,280	1,600	1,920	2,240	2,560	2,880	3,200	3,520	3,840	4,160
100	800	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000	4,400	4,800	5,200
120	960	1,440	1,920	2,400	2,880	3,360	3,840	4,320	4,800	5,280	5,760	6,240
140	1,120	1,680	2,240	2,800	3,360	3,920	4,480	5,040	5,600	6,160	6,720	7,280
160	1,280	1,920	2,560	3,200	3,840	5,120	5,760	6,400	6,400	7,040	7,680	8,320
180	1,440	2,160	2,880	3,600	4,320	5,040	5,760	6,480	7,200	7,920	8,640	9,360
200	1,600	2,400	3,200	4,000	4,800	5,600	6,400	7,200	8,000	8,800	9,600	10,400
220	1,760	2,640	3,520	4,400	5,280	6,160	7,040	7,920	8,800	9,680	10,560	11,440
240	1,920	2,880	3,840	4,800	5,760	6,720	7,680	8,640	9,600	10,560	11,520	12,480
260	2,080	3,120	4,160	5,200	6,240	7,280	8,320	9,360	10,400	11,440	12,480	13,520
280	2,240	3,360	4,480	5,600	6,720	7,840	8,960	10,080	11,200	12,320	13,440	14,560
300	2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000	13,200	14,000	15,600

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Presents tables and equations for estimating total cubic volumes of wood, wood residue, and bark for ponderosa pine, lodgepole pine, western larch, and Douglas-fir. Tables represent second-growth trees 80 years old or less, ranging in size from 1-1/2 inches d.b.h. to the maximum diameter measured for the respective species.

KEYWORDS: volume estimation, yield tables, merchantable volume, residue volume

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